US006665089B1

(12) **United States Patent**
Austin et al.

(10) **Patent No.: US 6,665,089 B1**
(45) **Date of Patent: Dec. 16, 2003**

(54) **CONTROL SYSTEM AND METHOD FOR A PORTABLE ELECTRONIC PRINTER**

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(73) Assignee: **Intermec IP Corp.**, Woodland Hills, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/289,243**

(22) Filed: **Apr. 9, 1999**

Related U.S. Application Data

(60) Provisional application No. 60/081,412, filed on Apr. 10, 1998, provisional application No. 60/081,372, filed on Apr. 10, 1998, provisional application No. 60/081,381, filed on Apr. 10, 1998, and provisional application No. 60/084,435, filed on May 6, 1998.

(51) **Int. Cl.**[7] **G06F 15/00**; B41J 29/38; B41J 29/393; G01D 9/00; G01D 15/66

(52) **U.S. Cl.** **358/1.18**; 358/1.18; 358/1.1; 358/1.9; 347/14; 347/17; 347/19; 346/1.1; 346/33; 346/140

(58) **Field of Search** 358/1.15–1.18, 358/14, 17, 19; 347/14–17, 19

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Primary Examiner—Edward Coles
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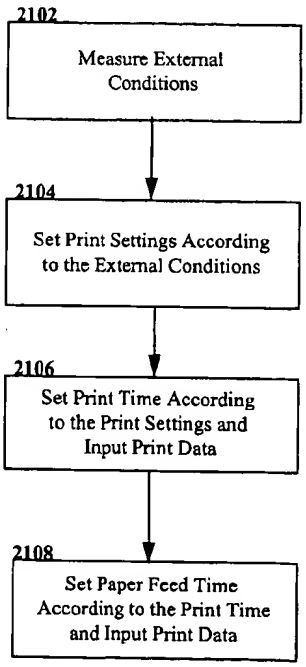
(74) *Attorney, Agent, or Firm*—Simmons, Perrine, Albright & Ellwood, P.L.C.

(57) **ABSTRACT**

A control system for a portable electronic printer is disclosed. The control system implements a method for performing a self-test of the hardware of a portable electronic printer, a method for monitoring the hardware of a portable electronic printer for a failure, a method for diagnosing a portable electronic printer, a method for booting a portable electronic printer having both volatile and non-volatile memory, a method for controlling the printing of data received from a serial transmission line whereby printing may be canceled, a method for controlling a printing system such that code or data in the printing system may be updated, a method of verifying a downloaded file in a printing system, a method for determining a communications protocol in a printing system, and a method for controlling communications in a printing system during a diagnostic routine.

35 Claims, 22 Drawing Sheets



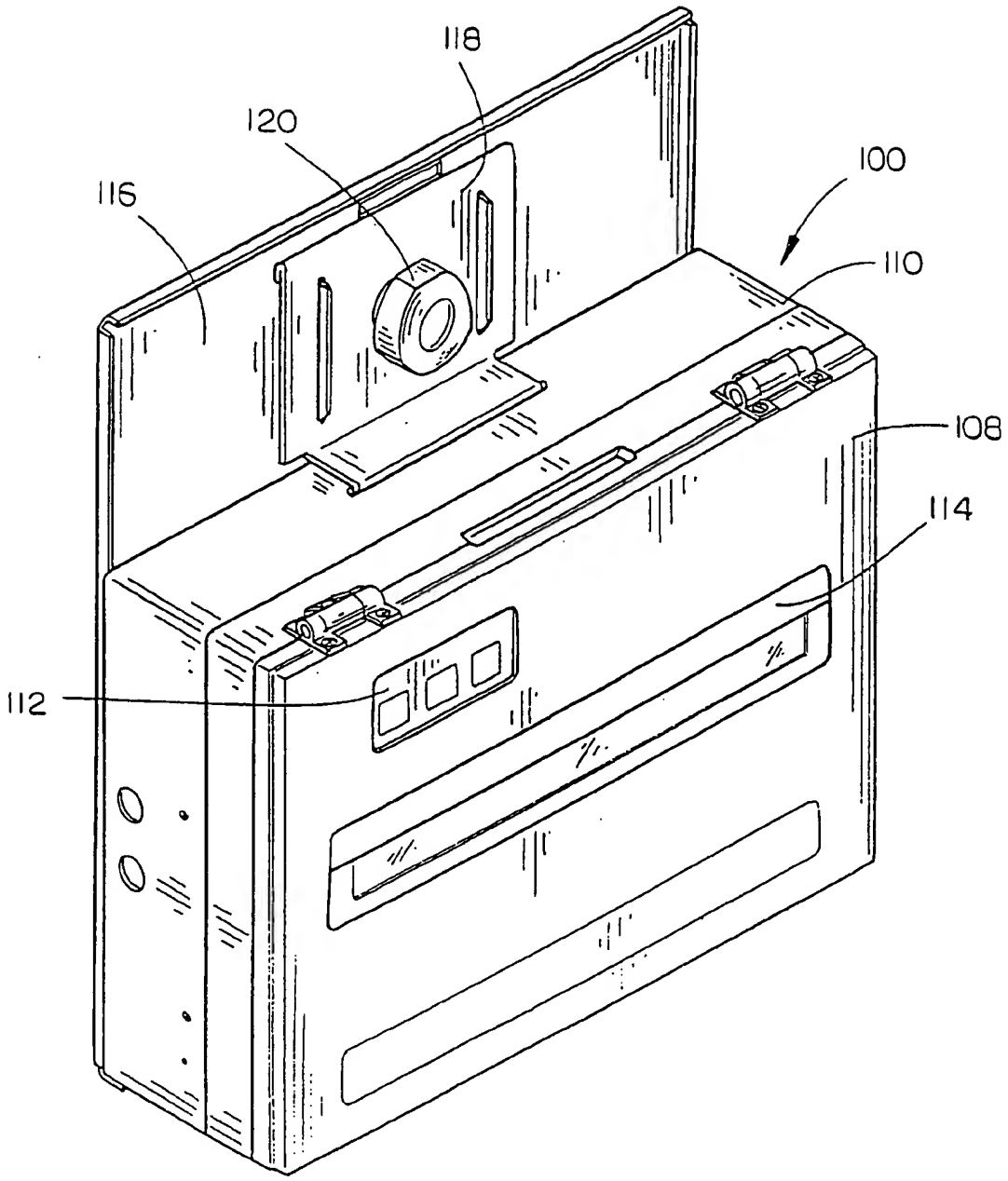


FIG. 1

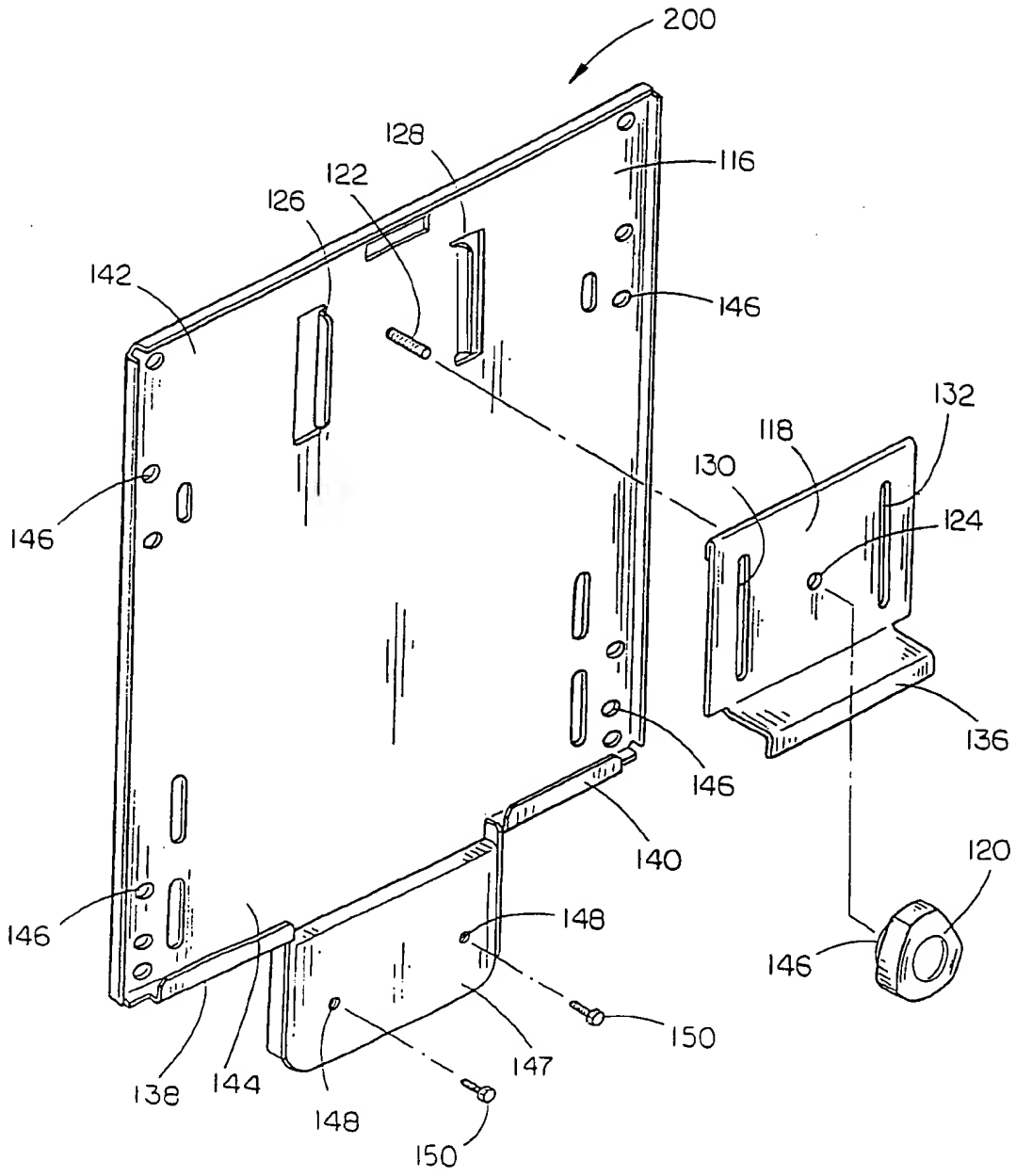

200
128
116
122
126
142
146
132
118
130
124
146
136
146
140
120
148
146
150
147
138
144
148
150

FIG. 2

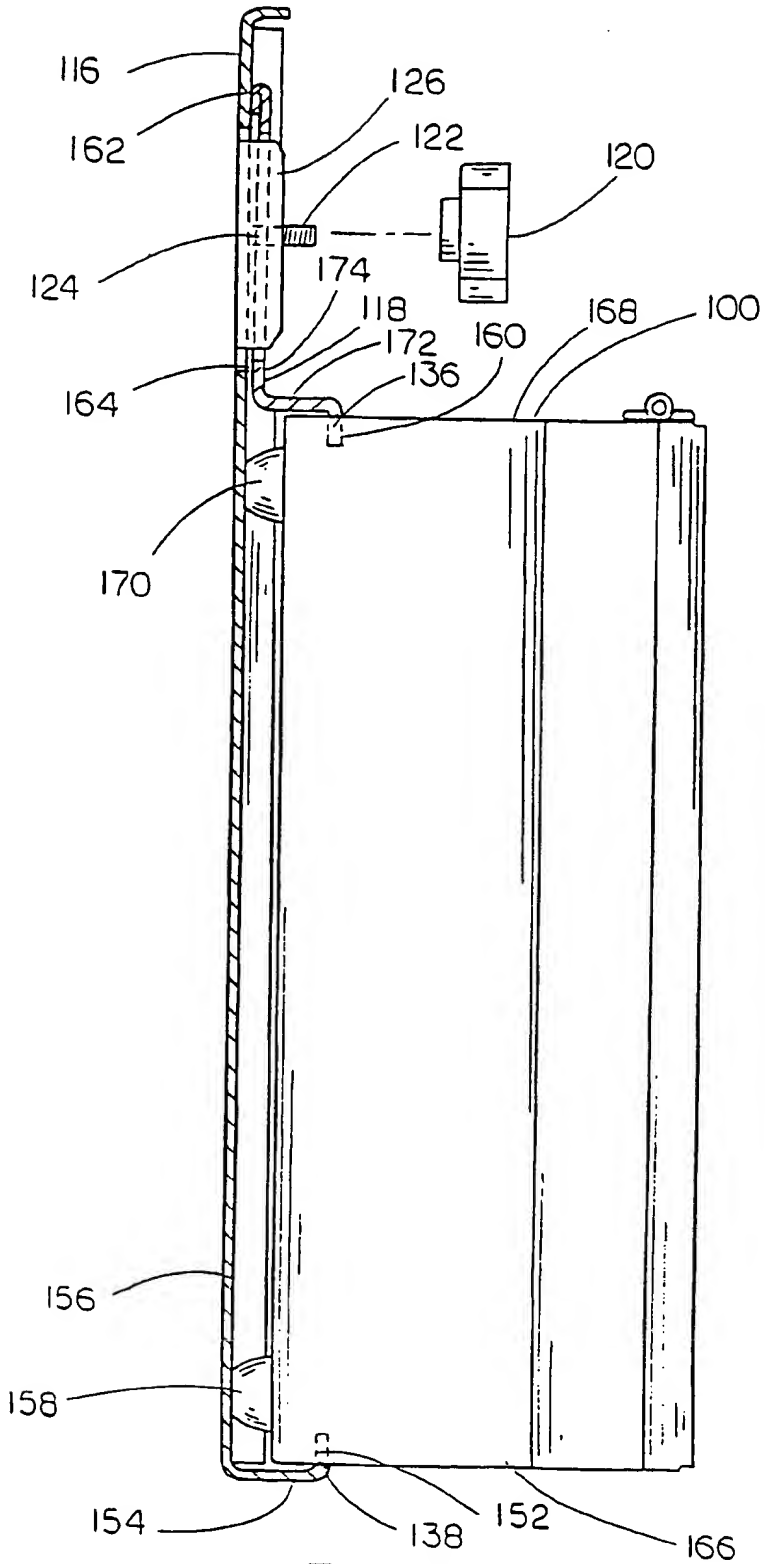

116
162
126
122
120
124
174
118
172
160
168
100
164
136
170
156
158
154
138
152
166

FIG 3

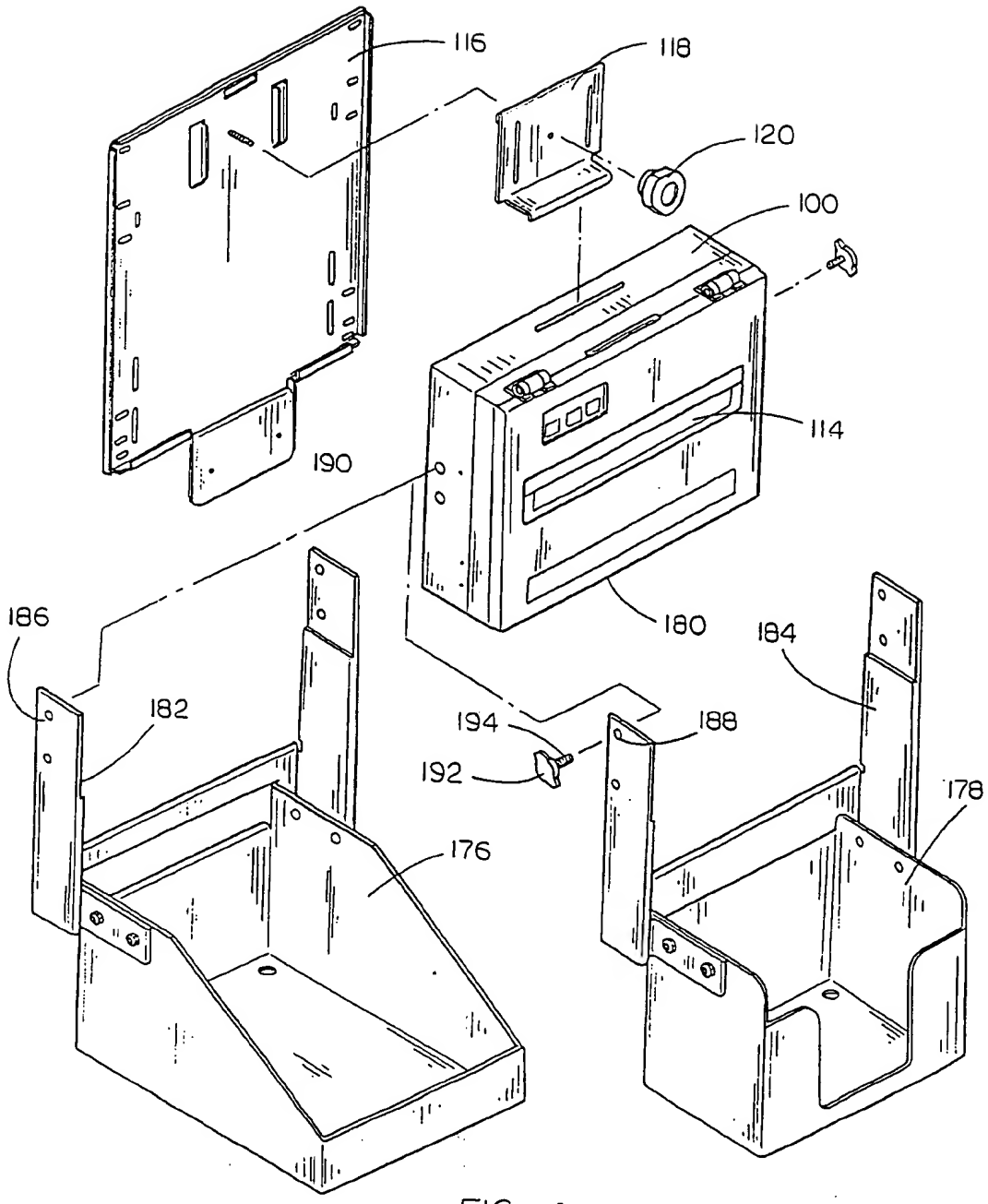


FIG. 4

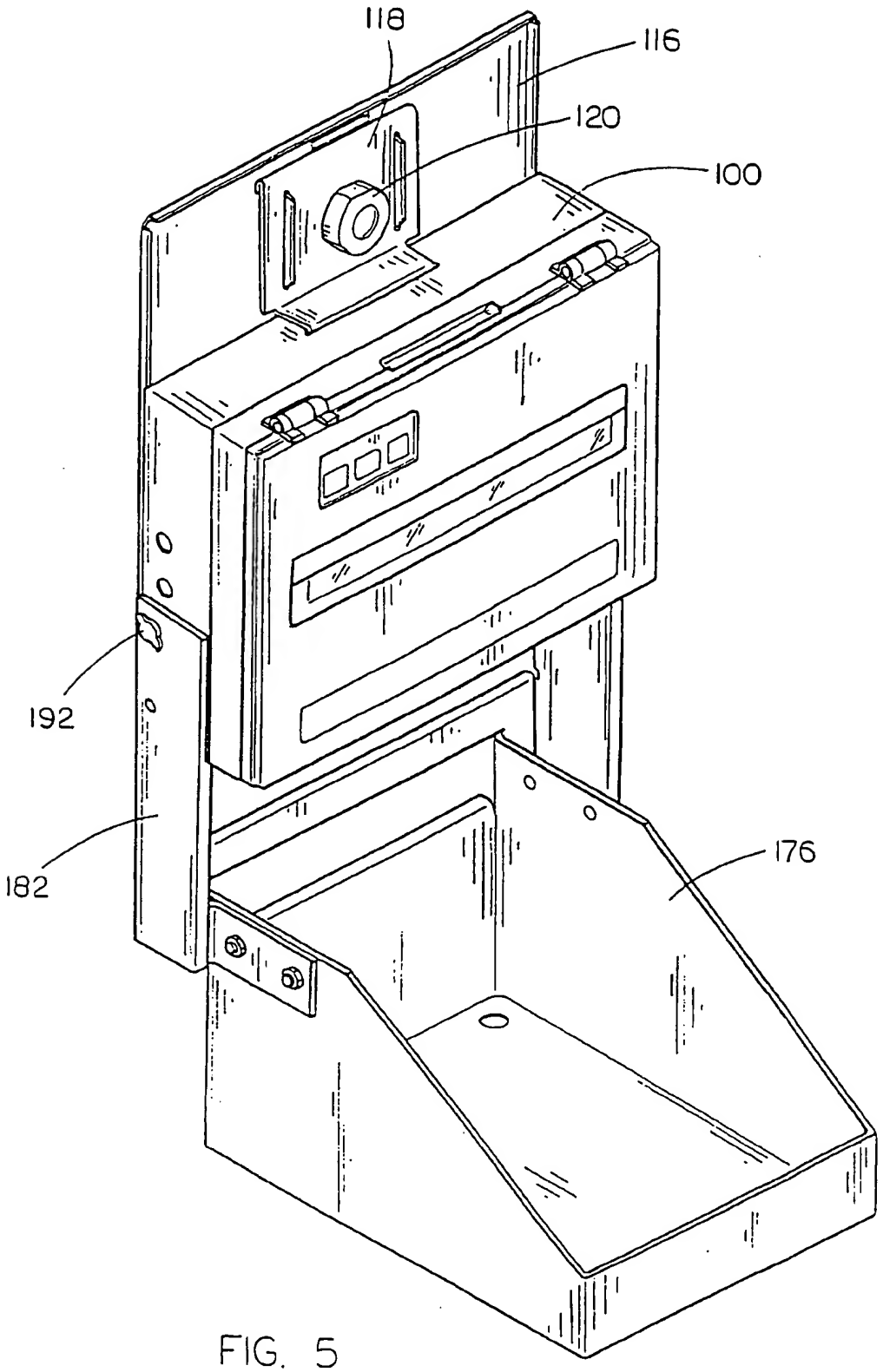


FIG. 5

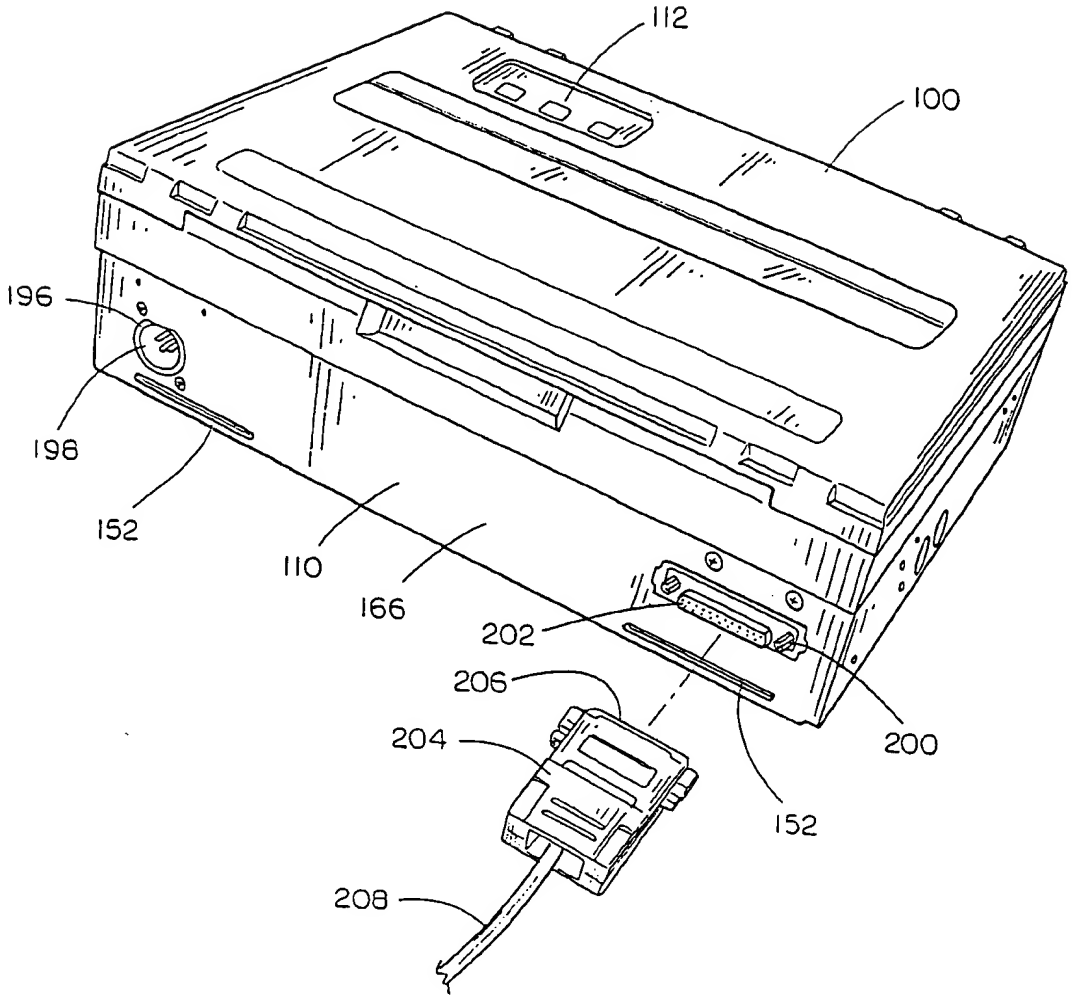


FIG. 6

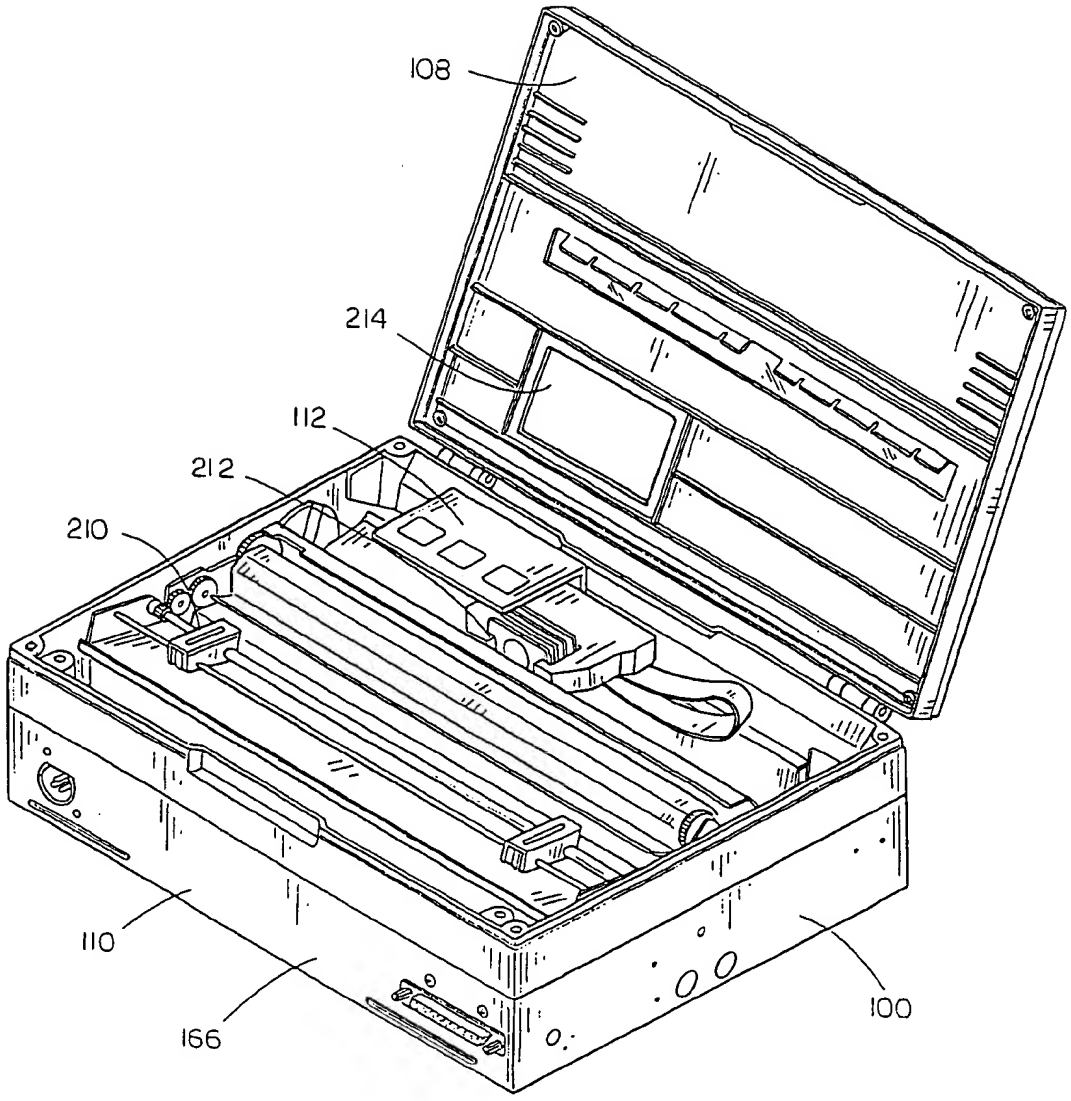


FIG. 7

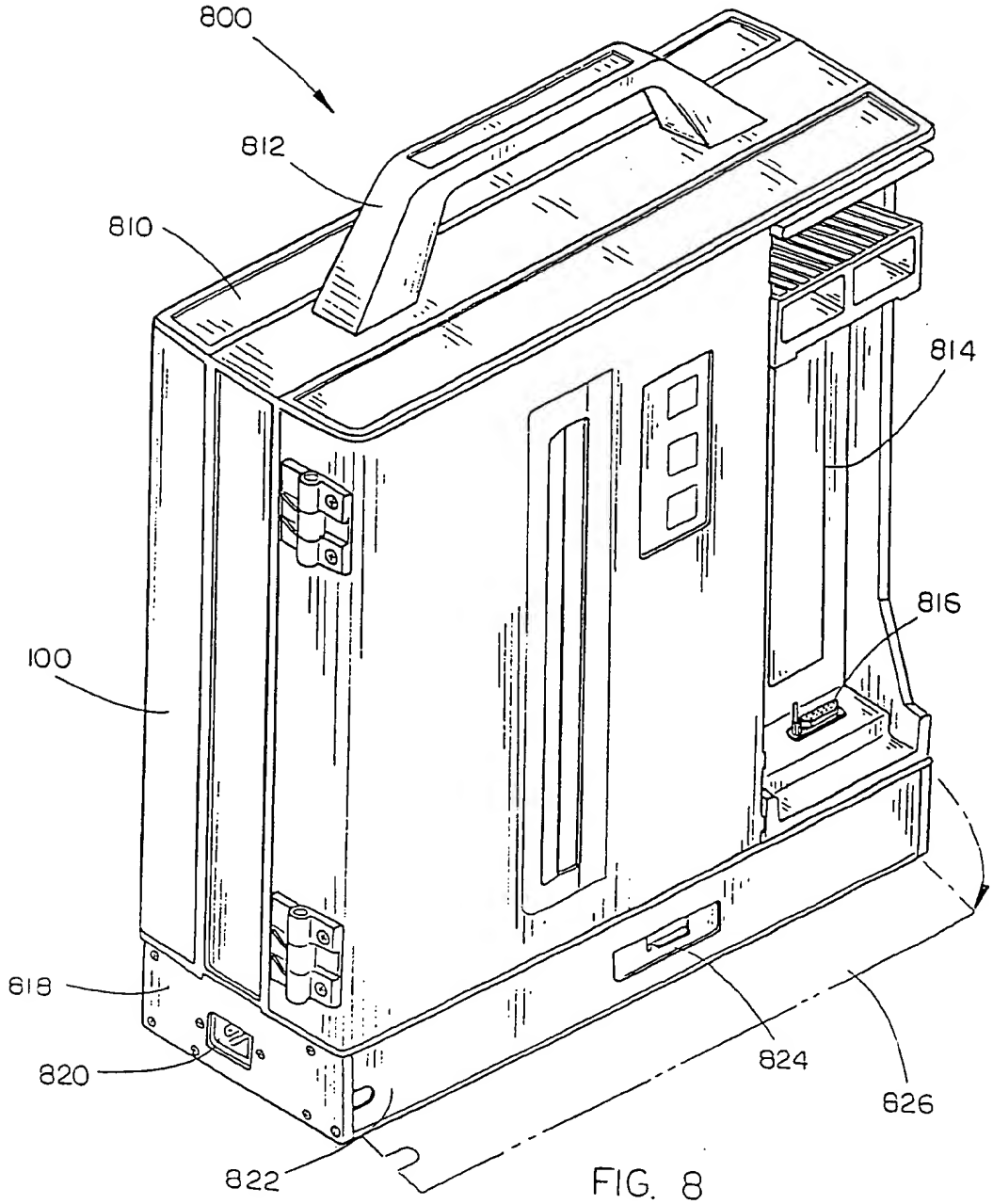


FIG. 8

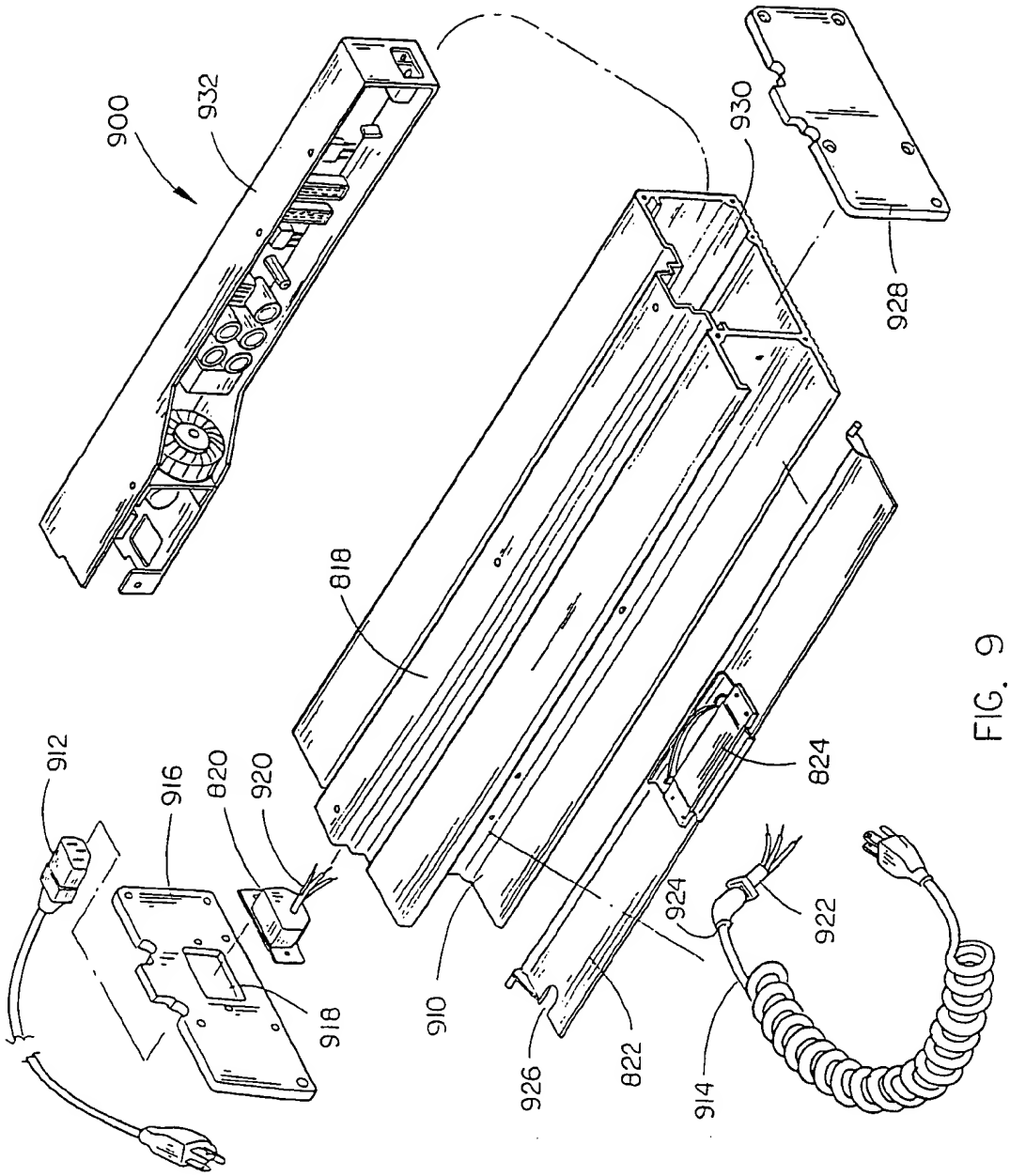

900
932
930
928
818
912
916
820
920
824
922
924
910
918
926
822
914

FIG. 9

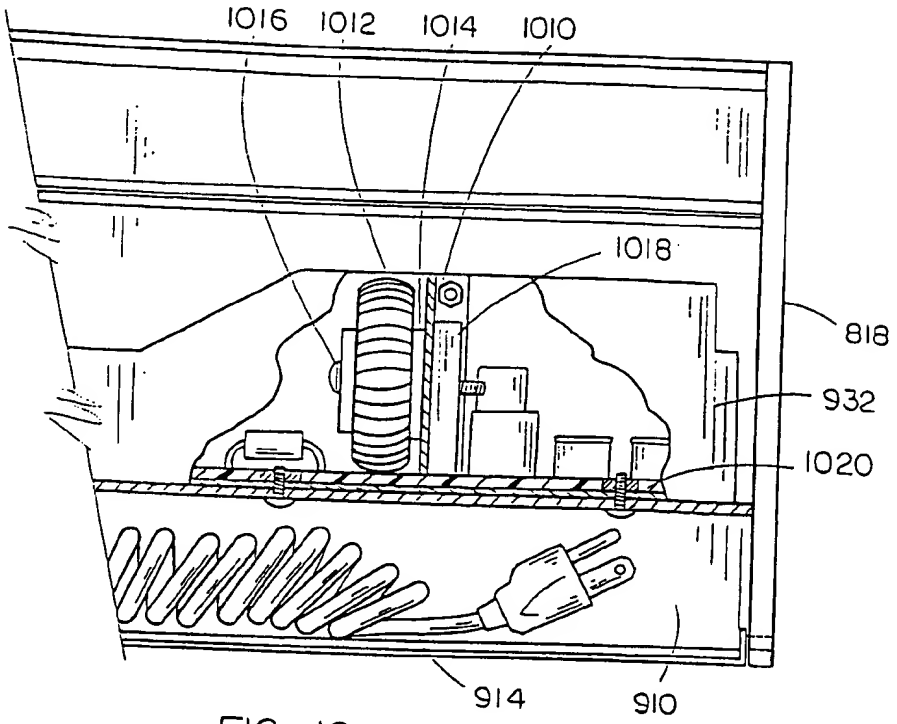

1016
1012
1014
1010
1018
818
932
1020
914
910

FIG. 10

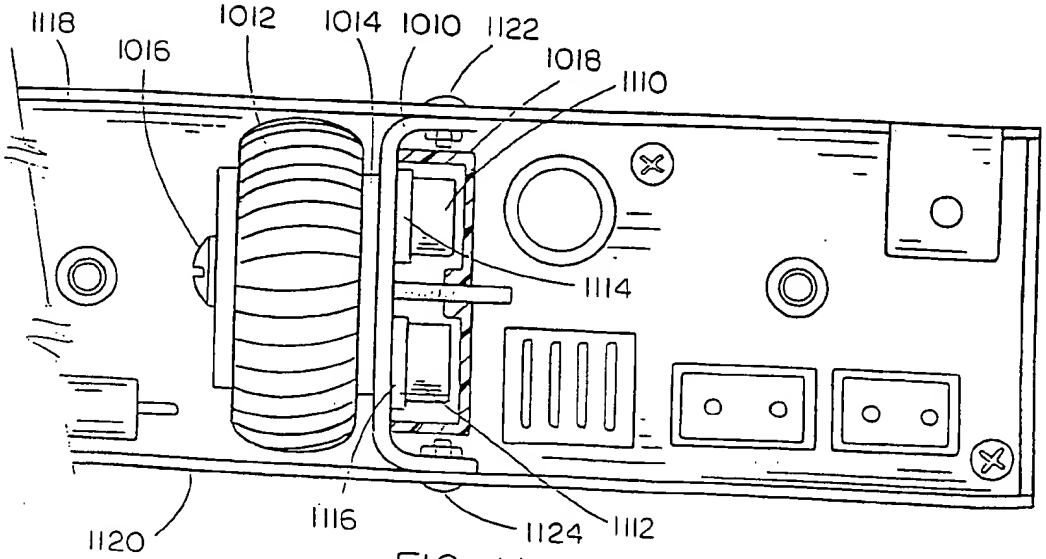

1118
1016
1012
1014
1010
1122
1018
1110
1114
1120
1116
1124
1112

FIG. 11

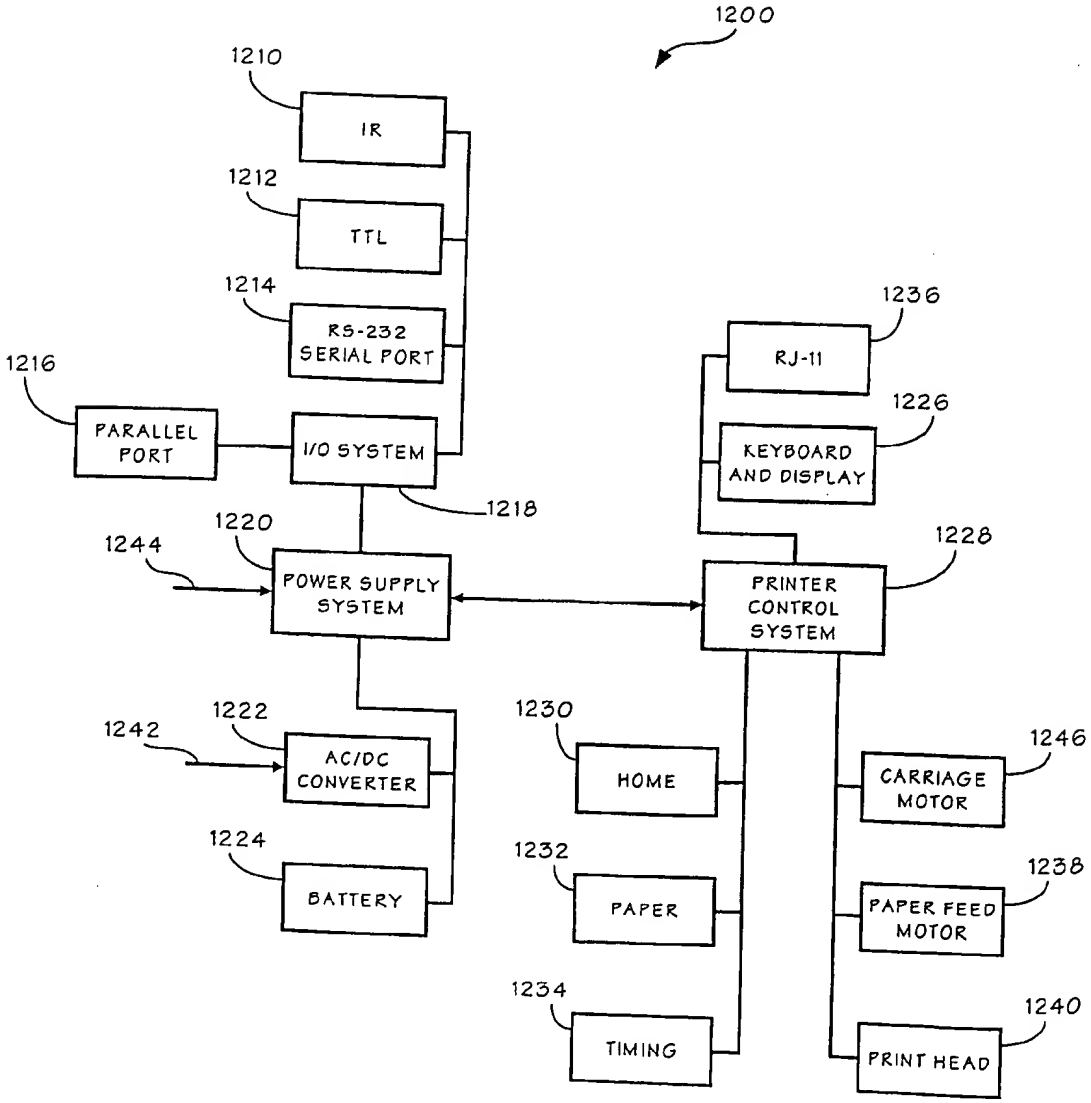

1200
1210
IR
1212
TTL
1214
RS-232 SERIAL PORT
1216
PARALLEL PORT
I/O SYSTEM
1218
1220
1244
POWER SUPPLY SYSTEM
1222
1242
AC/DC CONVERTER
1224
BATTERY
1236
RJ-11
1226
KEYBOARD AND DISPLAY
1228
PRINTER CONTROL SYSTEM
1230
HOME
1232
PAPER
1234
TIMING
1246
CARRIAGE MOTOR
1238
PAPER FEED MOTOR
1240
PRINT HEAD

FIG. 12

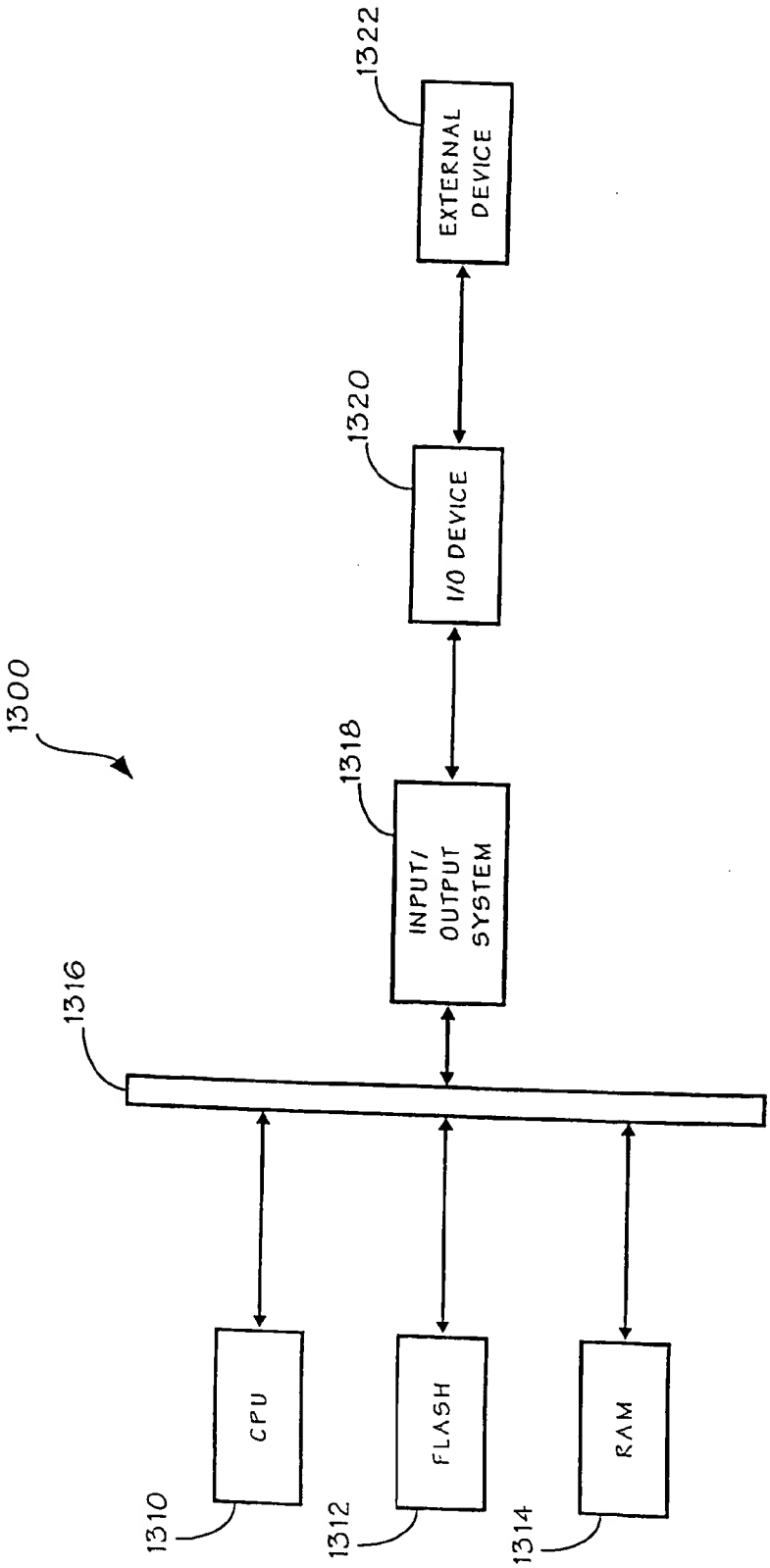

1322
EXTERNAL DEVICE
1320
I/O DEVICE
1300
1318
INPUT/ OUTPUT SYSTEM
1316
CPU
FLASH
RAM
1310
1312
1314

FIG. 13

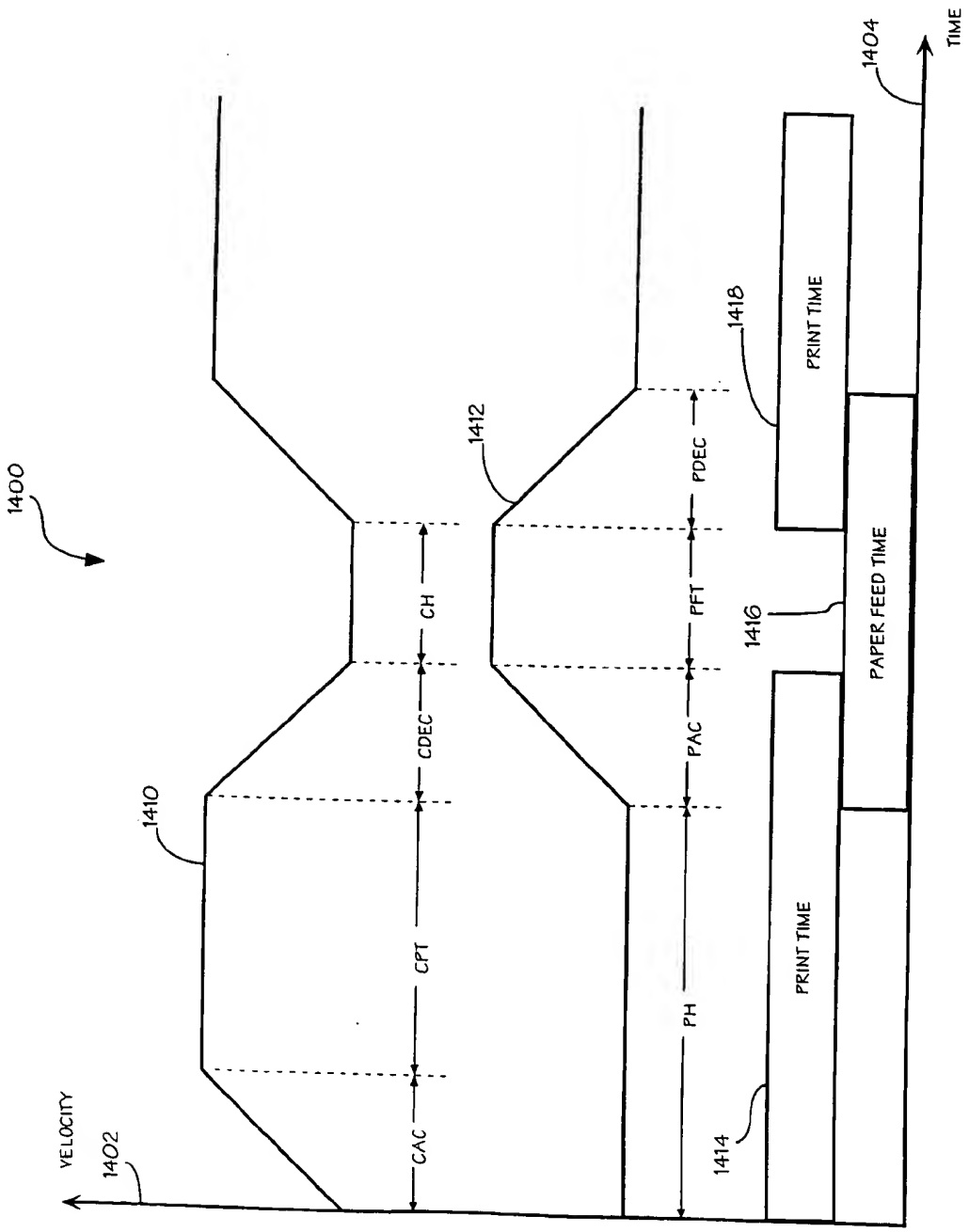

1400
1402
VELOCITY
1404
TIME
1410
1412
1414
1416
1418
CAC
CPT
CDEC
CH
PH
PAC
PFT
PDEC
PRINT TIME
PAPER FEED TIME
PRINT TIME

FIG. 14

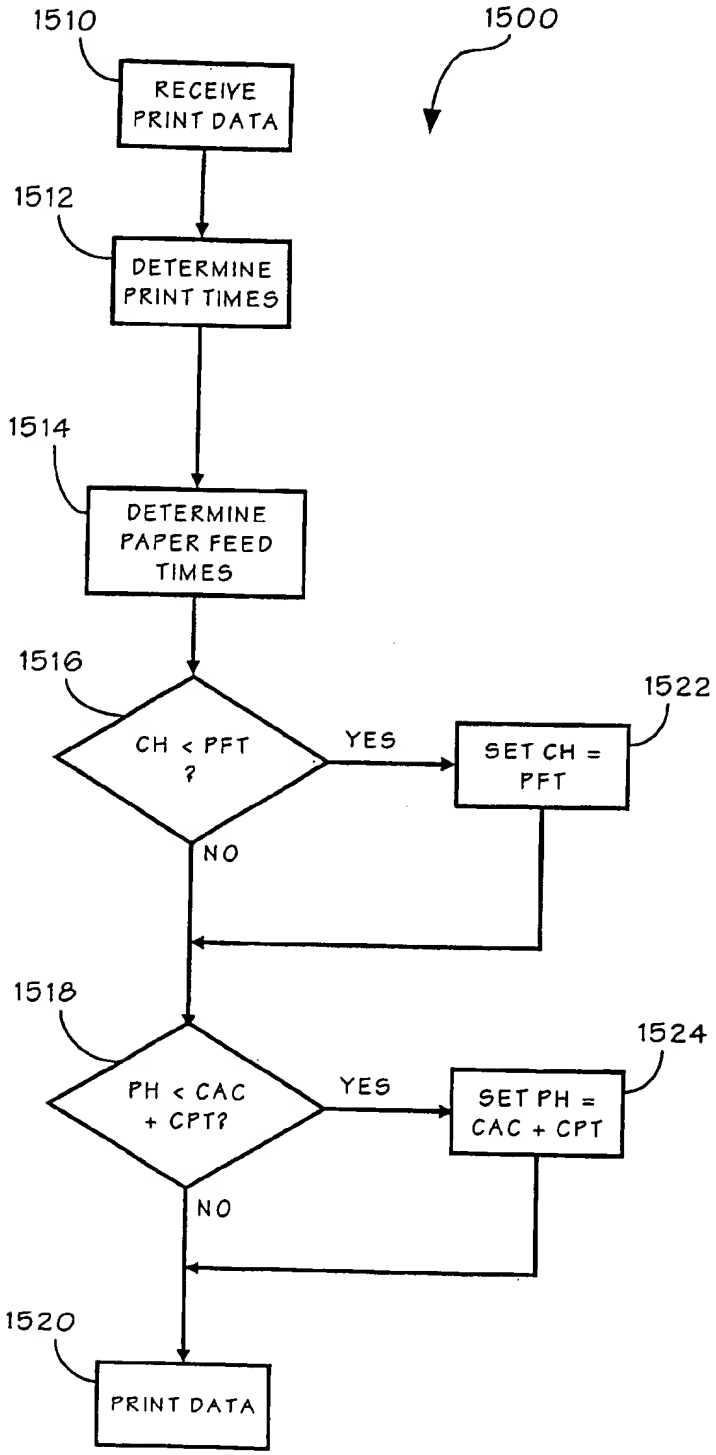

1510
1500
RECEIVE PRINT DATA
1512
DETERMINE PRINT TIMES
1514
DETERMINE PAPER FEED TIMES
1516
CH < PFT ?
YES
1522
SET CH = PFT
NO
1518
PH < CAC + CPT?
YES
1524
SET PH = CAC + CPT
NO
1520
PRINT DATA

FIG. 15

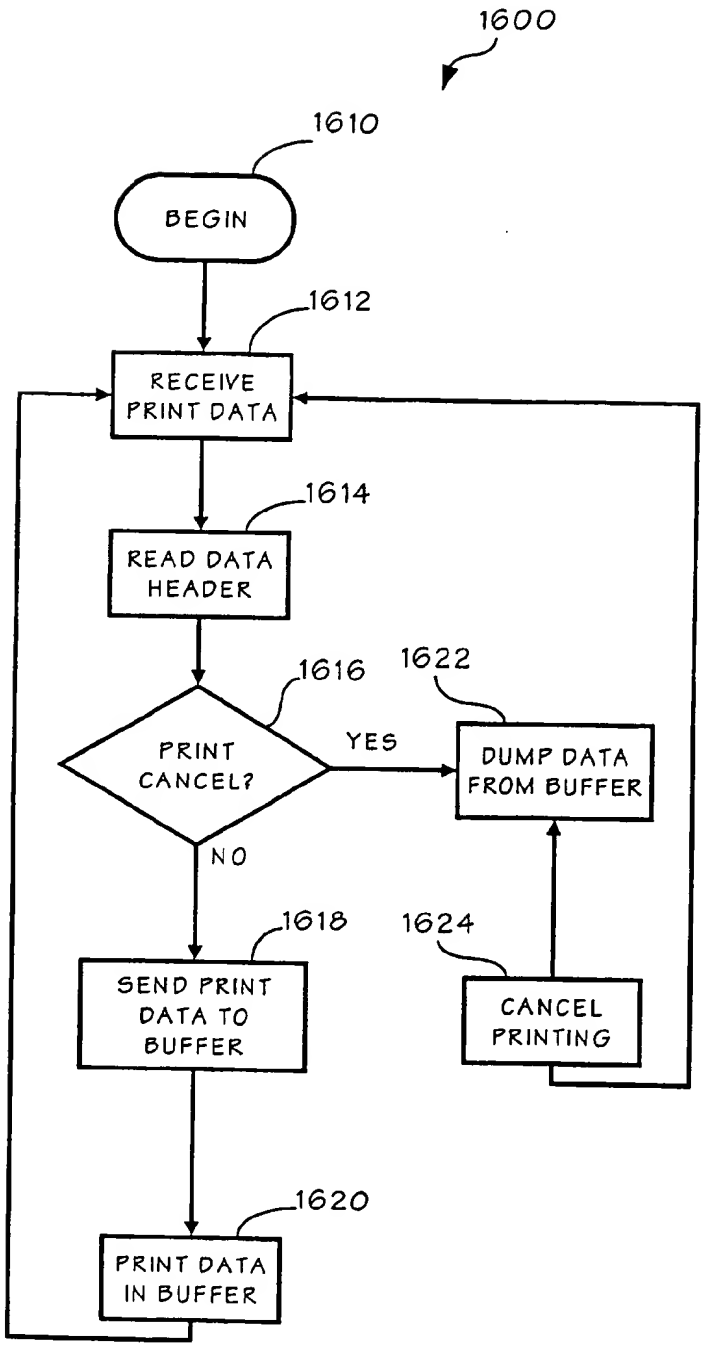

1600
1610
BEGIN
1612
RECEIVE PRINT DATA
1614
READ DATA HEADER
1616
PRINT CANCEL?
YES
1622
DUMP DATA FROM BUFFER
NO
1618
SEND PRINT DATA TO BUFFER
1624
CANCEL PRINTING
1620
PRINT DATA IN BUFFER

FIG. 16

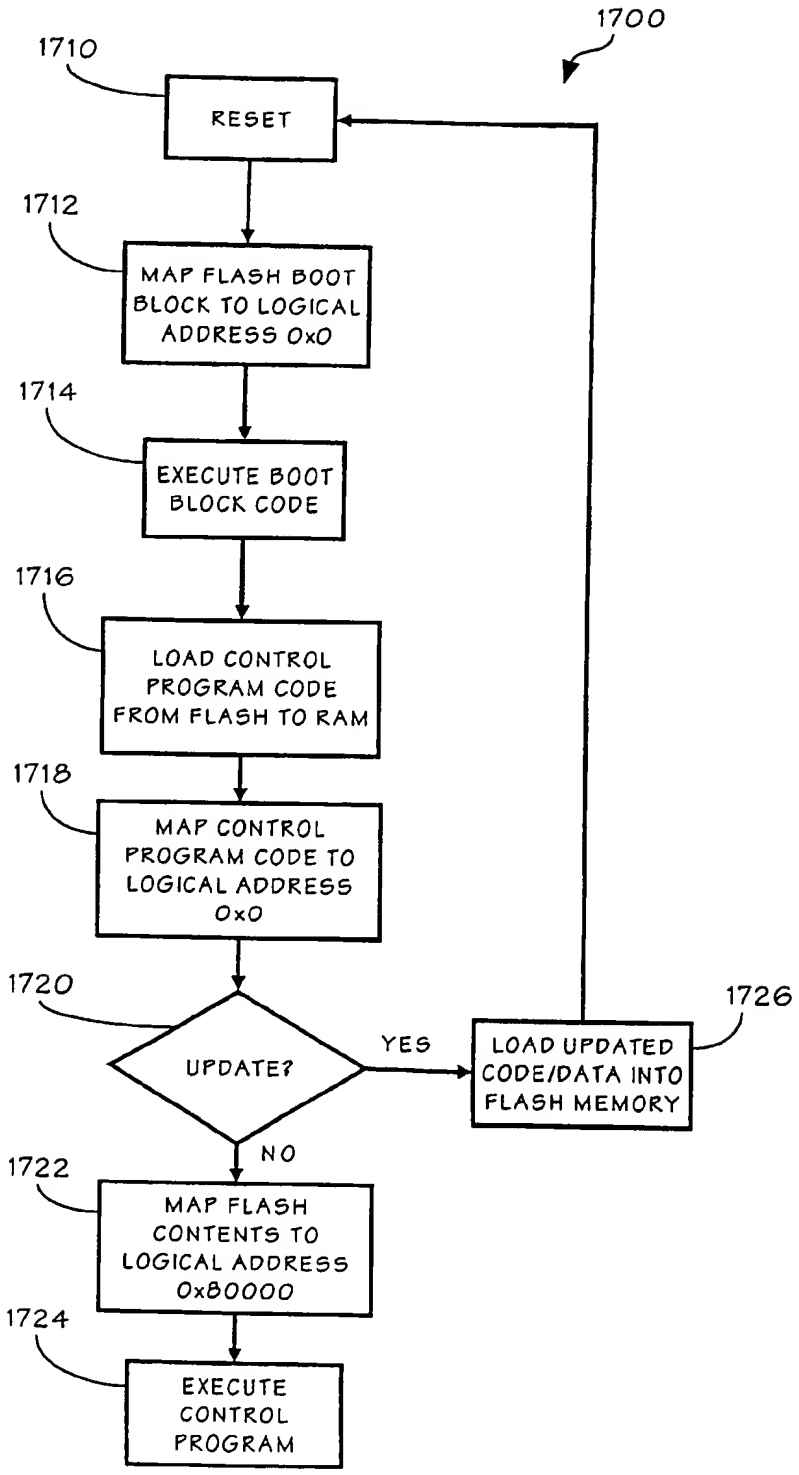

1700
1710
RESET
1712
MAP FLASH BOOT BLOCK TO LOGICAL ADDRESS 0x0
1714
EXECUTE BOOT BLOCK CODE
1716
LOAD CONTROL PROGRAM CODE FROM FLASH TO RAM
1718
MAP CONTROL PROGRAM CODE TO LOGICAL ADDRESS 0x0
1720
UPDATE?
YES
1726
LOAD UPDATED CODE/DATA INTO FLASH MEMORY
NO
1722
MAP FLASH CONTENTS TO LOGICAL ADDRESS 0x80000
1724
EXECUTE CONTROL PROGRAM

FIG. 17

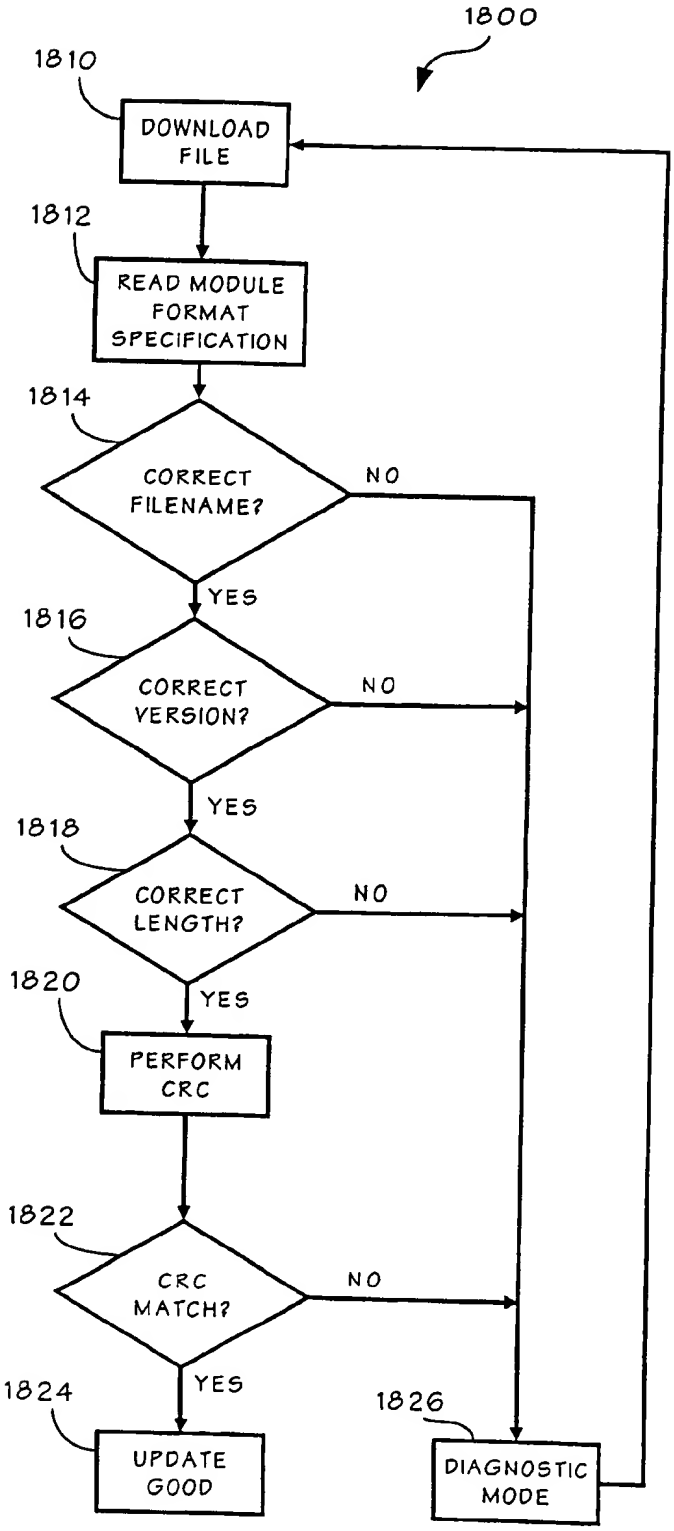

1800
1810
DOWNLOAD FILE
1812
READ MODULE FORMAT SPECIFICATION
1814
CORRECT FILENAME?
NO
YES
1816
CORRECT VERSION?
NO
YES
1818
CORRECT LENGTH?
NO
YES
1820
PERFORM CRC
1822
CRC MATCH?
NO
YES
1824
UPDATE GOOD
1826
DIAGNOSTIC MODE

FIG. 18

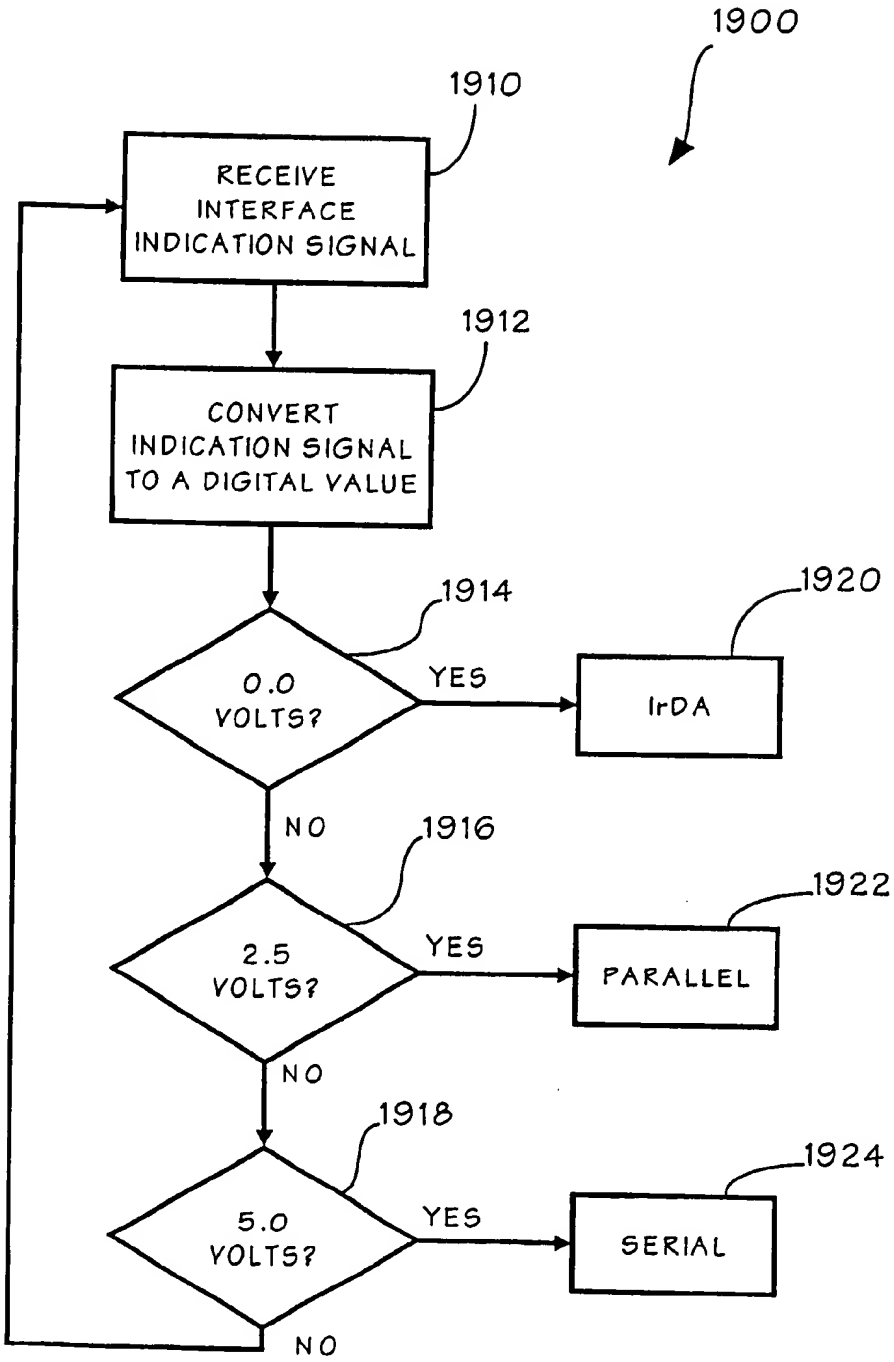

1900
1910
RECEIVE INTERFACE INDICATION SIGNAL
1912
CONVERT INDICATION SIGNAL TO A DIGITAL VALUE
1914
0.0 VOLTS?
YES
1920
IrDA
NO
1916
2.5 VOLTS?
YES
1922
PARALLEL
NO
1918
5.0 VOLTS?
YES
1924
SERIAL
NO

FIG. 19

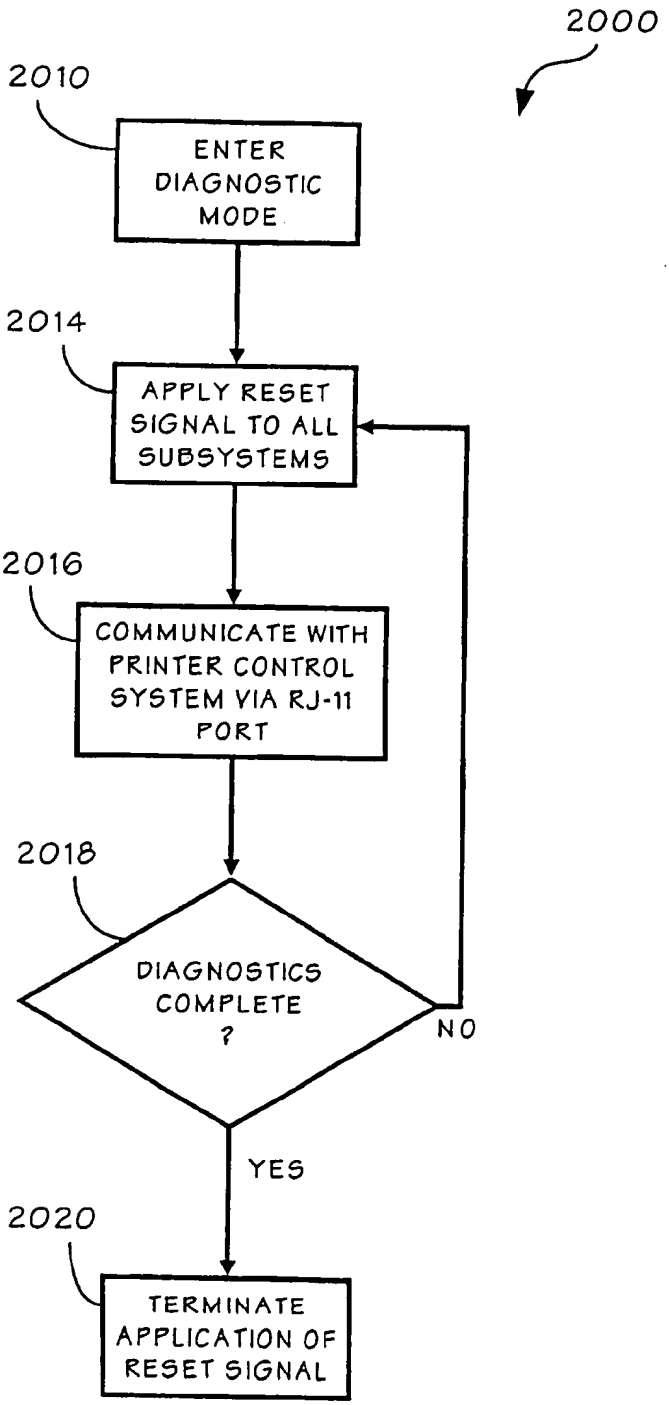

2000
2010
ENTER DIAGNOSTIC MODE
2014
APPLY RESET SIGNAL TO ALL SUBSYSTEMS
2016
COMMUNICATE WITH PRINTER CONTROL SYSTEM VIA RJ-11 PORT
2018
DIAGNOSTICS COMPLETE ?
NO
YES
2020
TERMINATE APPLICATION OF RESET SIGNAL

FIG. 20

FIG. 21

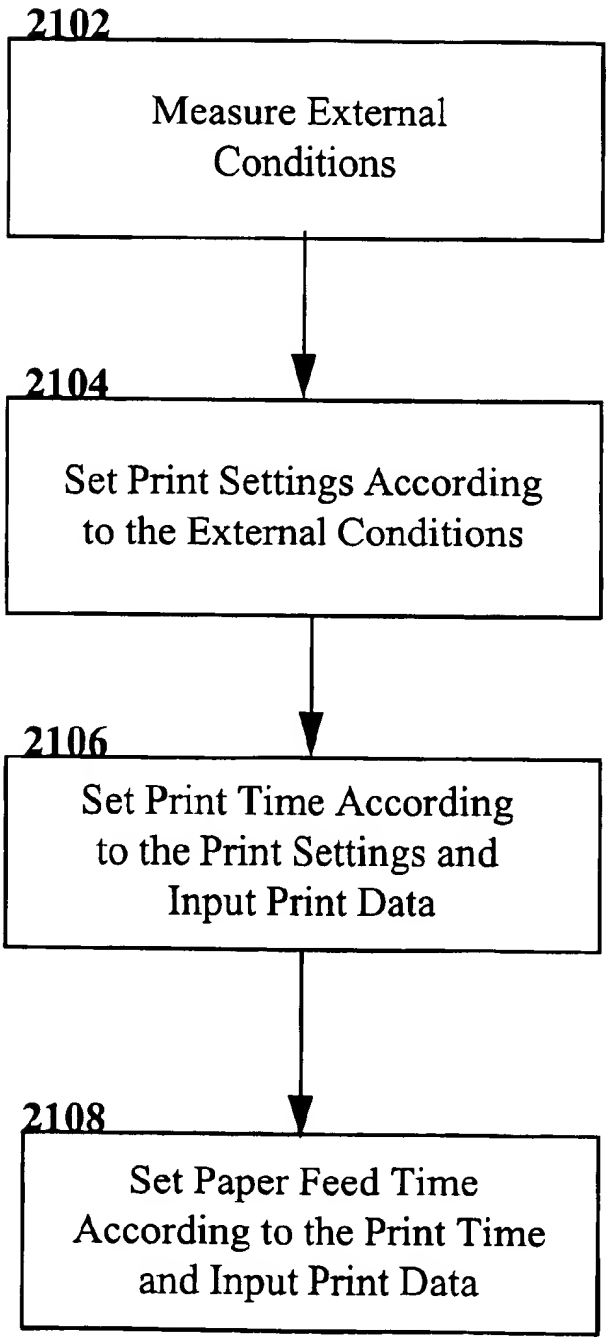

2102
Measure External Conditions
2104
Set Print Settings According to the External Conditions
2106
Set Print Time According to the Print Settings and Input Print Data
2108
Set Paper Feed Time According to the Print Time and Input Print Data

FIG. 22

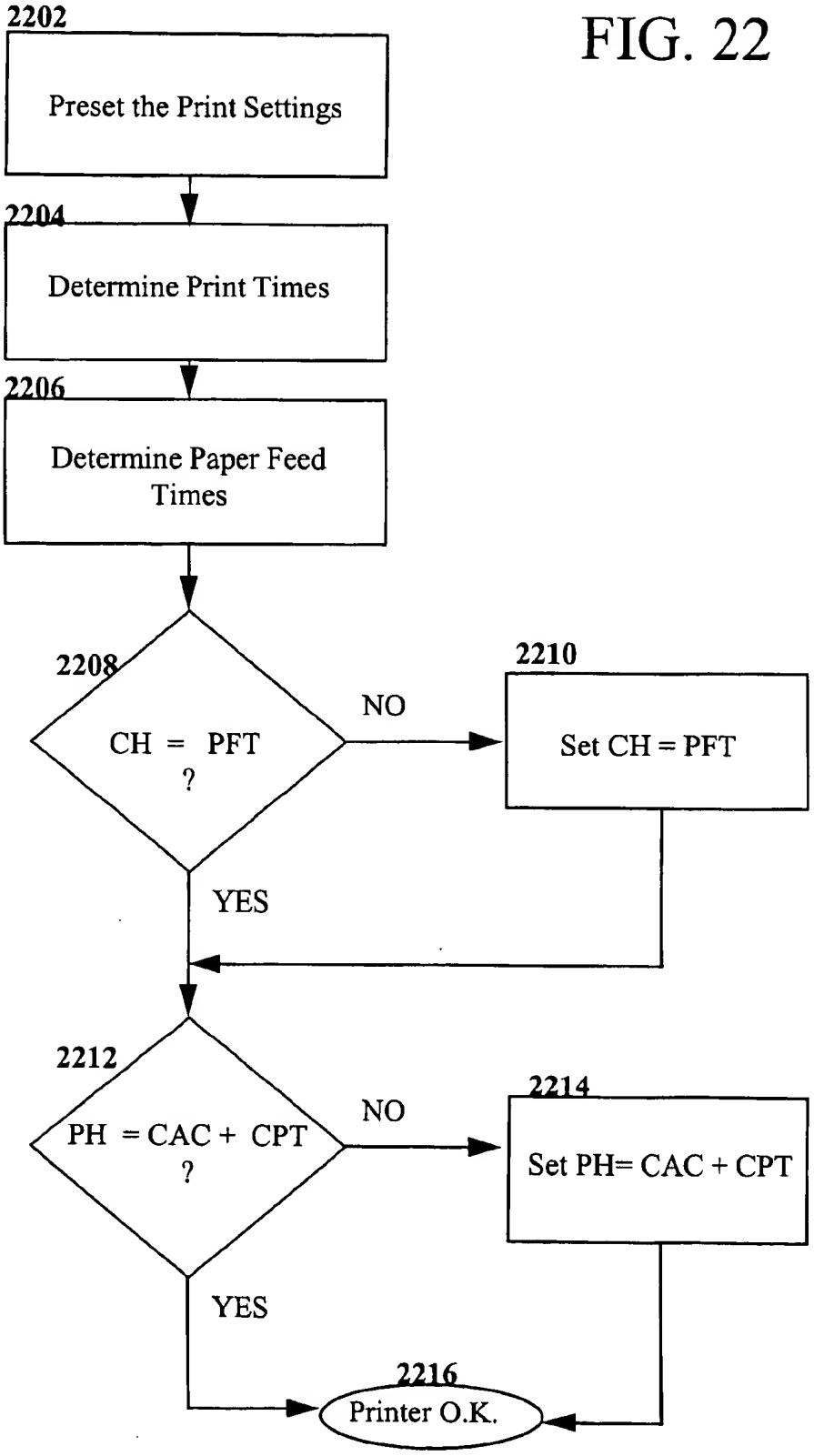
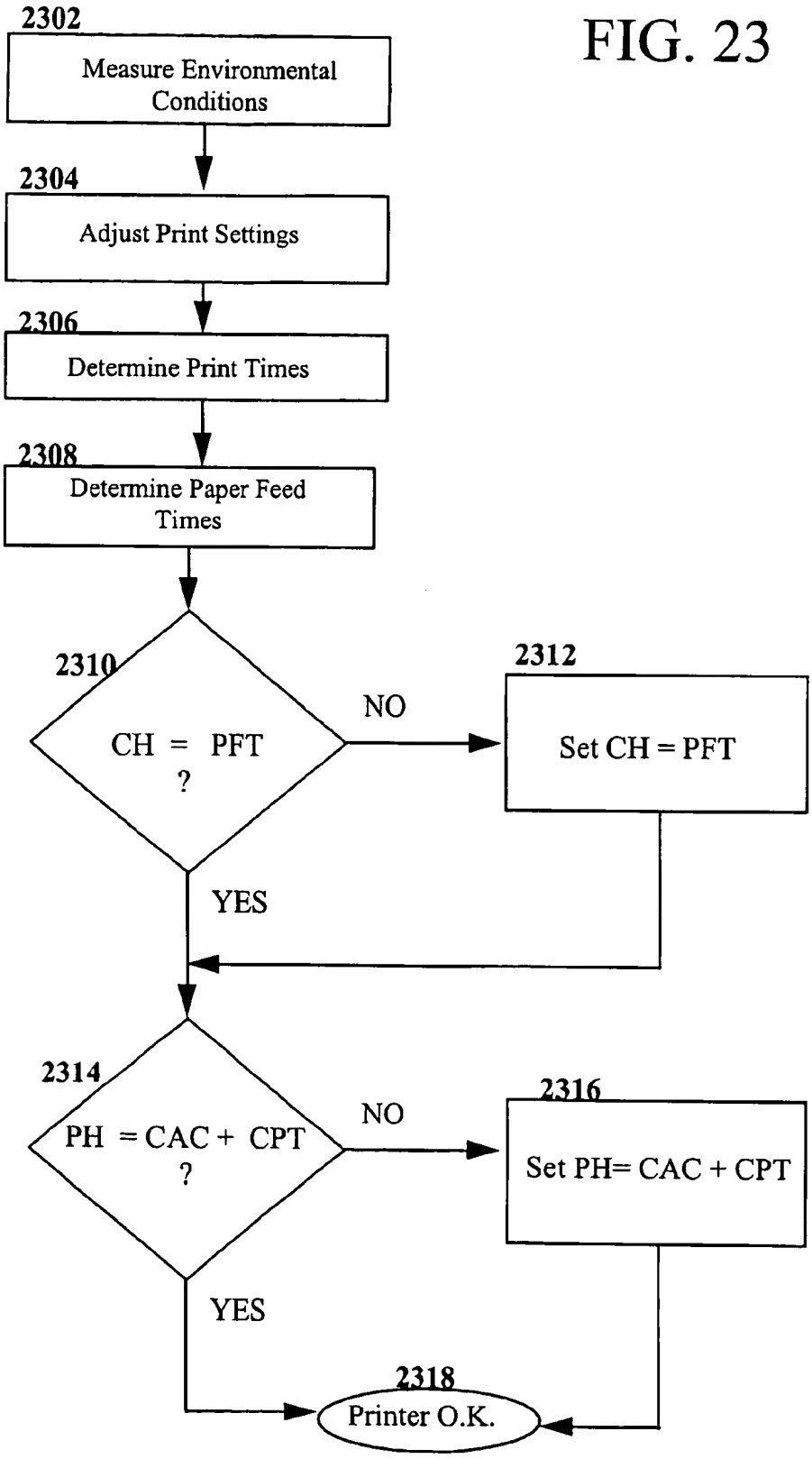

2202
Preset the Print Settings
2204
Determine Print Times
2206
Determine Paper Feed Times
2208
CH = PFT ?
NO
2210
Set CH = PFT
YES
2212
PH = CAC + CPT ?
NO
2214
Set PH= CAC + CPT
YES
2216
Printer O.K.

FIG. 23


2302
Measure Environmental Conditions
2304
Adjust Print Settings
2306
Determine Print Times
2308
Determine Paper Feed Times
2310
CH = PFT ?
NO
2312
Set CH = PFT
YES
2314
PH = CAC + CPT ?
NO
2316
Set PH= CAC + CPT
YES
2318
Printer O.K.

CONTROL SYSTEM AND METHOD FOR A PORTABLE ELECTRONIC PRINTER

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. 119 to the following U.S. provisional patent applications:

Provisional Application No. 60/081,412, filed Apr. 10, 1998,

Provisional Application No. 60/081,372, filed Apr. 10, 1998,

Provisional Application No. 60/081,381, filed Apr. 10, 1998, and

Provisional Application No. 60/084,435, filed May 6, 1998,

The above identified applications are all hereby incorporated by reference herein in their entireties. The two microfiche appendices of Provisional Application No. 60/084,435 are also hereby incorporated herein by reference in their entireties.

FIELD OF THE INVENTION

The present invention generally relates to the field of portable electronic printers, and particularly to an electronic printer for utilization with a portable hand-held computer.

BACKGROUND OF THE INVENTION

Portable hand-held computers are typically utilized for data collection and management in the modern computerized business world. For example, commercial transactions for the sale of goods may be stored in a portable hand-held computer that is carried by delivery personnel to a customer's place of business. After the delivery driver enters execution of the transaction into the hand-held computer, an invoice verifying the date, time and contents of the delivery is desired. The invoice may be conveniently printed with a portable printer to which the delivery driver may connect the hand-held computer.

The usefulness of portable printers has been enhanced by efforts in reducing the size and modularity of printers when compared to their respective forerunners. Also, minimization of tasks may further the utility of portable printers by route service people in operating the printers.

It is highly desirable to increase the efficiency and productivity of the user of the printer by improving the speed at which the printer operates. It would therefore be advantageous to provide a printer having an improved control system for controlling the operation of the printer motor controls and printing head such that the effective printing time for a given print job is reduced.

Furthermore, it is highly desirable that a portable printing system is adaptable to a variety of environments or applications. Thus, it would be desirable to provide a printer having a memory and file system that allows for updating program code and data such as printer fonts and character systems. The printer would therefore be capable of being adapted to a variety of applications for use with a multiplicity of countries or languages. An advanced printer control system would additionally provide advanced control features such as the ability to cancel printing jobs with a serial interface without having to first print the entire print buffer, or to verify the integrity of files downloaded into an updateable file system, among other advantages.

It is also highly desirable that a printer system be able to adjust its print settings and print time so as to adequately

function in different environments or with different print media. For instance, in extremely cold environments, it is desirable to increase the impact force at which a contact printer strikes the paper when printing. In addition, when thick print media is used (e.g. five part carbon copy paper as opposed to three part carbon copy paper) it is likewise desirable to increase the impact force at which a contact printer strikes the print media. Environmental conditions such as temperature, barometric pressure, or atmospheric pressure may also affect other print settings of a print system. Thus, in a laser printer, a contact printer or an ink jet printer, it may be desirable to increase the temperature of operation of the printer when the print system is used in extreme environmental conditions.

SUMMARY OF THE INVENTION

The present invention is directed to a control system for a portable electronic printer. The control system of the present invention implements, among other things, a method for performing a self-test of the hardware of a portable electronic printer, a method for monitoring the hardware of a portable electronic printer for a failure, a method for diagnosing a portable electronic printer, a method for booting a portable electronic printer having both volatile and non-volatile memory, a method for controlling the printing of data received from a serial transmission line whereby printing may be canceled, a method for controlling a printing system such that code or data in the printing system may be updated, a method of verifying a downloaded file in a printing system, a method for determining a communications protocol in a printing system, and a method for controlling communications in a printing system during a diagnostic routine.

It is to be understood that both the forgoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention as claimed. The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate an embodiment of the invention and together with the general description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The numerous advantages of the present invention may be better understood by those skilled in the art by reference to the accompanying figures in which:

FIG. **1** is an illustration of a portable electronic printer in accordance with the present invention;

FIG. **2** is an illustration of a mounting system for the portable electronic printer of the present invention;

FIG. **3** is an illustration of a printer and printer mounting system of the present invention;

FIGS. **4** and **5** are illustrations of an assembly of a printing system in accordance with the present invention;

FIG. **6** is an illustration of a printer in accordance with the present invention;

FIG. **7** is an illustration of the internal mechanisms of a printer of the present invention;

FIG. **8** is an illustration of a portable printing system in accordance with the present invention;

FIG. **9** is an illustration of a power supply foot assembly for a portable printing system in accordance with the present invention;

FIGS. **10** and **11** are illustrations of a power supply circuit assembly in accordance with the present invention;

FIG. **12** is a block diagram of the electronic hardware components of a portable electronic printer of the present invention;

FIG. **13** is a block diagram of a hardware system for a portable electronic printing system in accordance with the present;

FIG. **14** is a timing diagram for illustrating simultaneous dual motor control of a printer in accordance with the present invention;

FIG. **15** is a flow diagram illustrating a method of operation of the printing control system in accordance with the present invention;

FIG. **16** is a flow diagram of a method for controlling and for canceling a printing operation of the printing system of the present invention;

FIG. **17** is a flow diagram of a method for loading updated code or data into the printing system of the present invention;

FIG. **18** is a flow diagram of a method for verifying updated code or data loaded into the printing system in accordance with the present invention will be discussed.

FIG. **19** is a flow diagram of a method for automatically determining the communication protocol for data received by the printer of the present invention; and

FIG. **20** is a flow diagram of a method for controlling communication during a diagnostics mode.

FIG. **21** is a flow diagram illustrating a method of operation of a printing system in accordance with an embodiment of the present invention.

FIG. **22** is a flow diagram illustrating a method of operation of a printing system in accordance with an embodiment of the present invention.

FIG. **23** is a flow diagram illustrating a method of operation of a printing system in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the presently preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings.

Referring now to FIG. **1**, a portable electronic printer in accordance with the present invention will be discussed. The printer **100** comprises a printer housing **110** having a top cover **108** and a control keypad **112** and paper egress aperture **114** disposed on top cover **108**. For mounting of printer **100** on a vertical surface such as a wall of a service vehicle, printer **100** may be affixed to a mounting plate **116**. A mounting bracket **118** and mounting knob **120** robustly and securely fasten printer **100** to mounting plate **116** yet allow for rapid and simple removal or replacement of printer **100** by a user without requiring tools.

Referring now to FIG. **2**, a mounting system for the portable electronic printer of the present invention is shown. Mounting system **200** generally comprises mounting plate **116**, mounting bracket **118** and mounting knob as shown in FIG. **1**. A threaded bolt **122** is cantileveredly disposed at the top end **142** of mounting plate **116**. Threaded bolt **122** and mounting knob together function as a fastener for fastening mounting bracket **118** to mounting plate **116**. Mounting bracket **118** has an aperture **124** for allowing passage of bolt **122** through aperture **124** in a clearance fit relationship. Mounting plate **116** further has tabs **126** and **128** extending perpendicularly from mounting bracket and adjacently disposed on either side of bolt **122**. Mounting bracket includes linear slits **130** and **132** corresponding to tabs **126** and **128** which allow tabs **126** and **128** to pass therethrough as bolt **122** extends through aperture **124**. The spatial positing and alignment of bolt **122**, aperture **124**, tabs **126** and **128**, and slits **130** and **132** constrain the position of mounting bracket **118** with respect to mounting plate **116**. Mounting knob **120** includes a threaded cavity **146** that corresponds to and mates with threaded bolt **122**, thereby allowing mounting knob **120** to be threaded onto bolt **122** and securely fasten mounting bracket **118** against mounting plate **116**.

Mounting plate **116** further includes an array of apertures **146** that allow mounting plate **116** to be securely mounted to a vertical support surface, e.g., bolted to a wall. Tabs **138** and **140** are disposed near the bottom end **144** of mounting plate **116** and arranged parallel to plate **116**. A mounting tab **147** is also disposed at the bottom **144** of mounting plate **116** for allowing a printer accessory such as a paper tray (not shown) to be mounted to mounting plate **116**. Mounting tab **147** may include threaded cavities for accepting threaded bolts **150** in order to fasten an accessory to mounting tab **147**.

Referring now to FIG. **3**, a printer and printer mounting system of the present invention will be discussed. Printer **100** includes a slot **152** disposed at the bottom side **166** of printer. When printer **100** is mounted onto mounting plate **116**, tab **138** of mounting plate extends into slot **152** of printer **100**. When mounting plate **116** is attached to a vertical support surface, printer **100** is supported by tab extension **154** of mounting plate **116**. Tab **138** prevents movement of printer **100** in a direction perpendicular to mounting plate **116**. Pinter foot **158** provides a spacing function for printer **100** by spacing slot **152** in alignment with tab **138** when printer foot **158** contacts the vertical surface **156** of plate **116**. The size of foot **158**, the length of tab extension, and the position of slot **152** are selected to allow such a relationship.

A slot **160** is similarly disposed at a top side **168** of printer **100** for allowing a tab **136** of bracket **118** to extend into slot **160** in a manner similar to the extension of tab **138** into slot **152** at the bottom side **166** of printer **100**. Bracket **118** is affixed to plate **116** by allowing passage of bolt **122** and tab **126** through aperture **124** and slit **130**, respectively. Bracket **118** includes a folded tab **162** as shown which contacts vertical surface **156** of plate **116**. Printer foot **170** provides a spacing function for printer **100** in a manner similar to that provided by printer foot **158**. Printer foot **170** spaces slot **160** in alignment with tab **136** when printer foot **170** contacts the vertical surface **156** of plate **116** when bracket **118** is disposed onto bolt **122**. The size of foot **170**, the thickness of folded tab **162**, the length of tab extension **172** of bracket **118** and the position of slot **136** position the bottom end **174** of bracket **118** a distance away from vertical surface **156** of plate **116** when folded tab **162** contacts vertical surface **156** of plate **116** and tab **136** extends into slot **160** of printer **160** such that a gap **164** is formed between bottom end **174** of bracket **118** and vertical surface **156** of plate **116**. Thus, bracket **118** functions as a lever wherein folded tab **162** functions as the fulcrum of the lever.

As mounting knob **120** is threaded onto bolt **122**, knob **120** applies force to bracket **118**. The force generated by the threading of knob **120** onto bracket **118** is transferred from bracket **118** to printer **100** at slot **160** via tab **136**, thereby causing bracket **118** to pivot about the fulcrum point provided by folded tab **162**, moving bottom end **174** of bracket **118** toward vertical surface **156** of plate **116** and causing gap **164** to diminish. Printer feet **158** and **170** provide resistance to the applied force through compression of feet **158** and **170**

against vertical surface **156**. Printer feet **158** and **170** preferably comprise a rugged, springy, compressible material having a compliance (where the compliance of a spring is the reciprocal of stiffness and is measured in inverse newtons) selected to robustly secure printer **100** in contact with plate **166** and to provide shock absorption and transfer of energy applied to either plate **116** or printer **100**. Printer is thereby ruggedly affixed to a vertical support surface to which mounting plate **116** is attached.

Referring now to FIGS. **4** and **5**, an assembly of a printing system in accordance with the present invention will be discussed. As can be seen in FIG. **4**, printer **100** may be quickly and easily attached to mounting plate **116** and secured thereto with mounting bracket **118** and mounting knob **120**. Additionally, paper trays **176** and **178** may be attached to printer **100**. Paper tray **176** may carry paper divided into elongated sections and paper tray **1787** may carry paper of shorter sections. Paper loaded in either paper tray **176** or **178** is typically continuous-form including perforations delineating each individual page such that an entire series of pages may be fed into printer **100** via a paper intake aperture and emitted from paper egress aperture **114**, for example. Paper may be tractor or sprocket fed wherein rotatably mounted pins (not shown) in printer **100** engage with a row of holes disposed along either edge of the paper such that the paper is driven through printer **100** via movement of the pins.

Paper trays **176** and **178** include support brackets **182** and **184** each having apertures **186** and **188** corresponding to a threaded cavity **190** of printer **100**. Apertures **186** and **188** align with cavity **190** to allow passage of a support bracket mounting knob **192** having a threaded bolt that passes through apertures **186** and **188** into cavity **190**, thereby fastening either bracket **182** or **184** to printer **100** according to the selected paper tray. A completely assembled printer mounting system is shown in FIG. **5**.

Referring now to FIG. **6**, a printer in accordance with the present invention will be discussed. Printer **100** includes a power adapter port **196** disposed at the bottom side **166** of printer **100** for connecting the printer to an external power source. The power source may be an ac or a dc power source, for example, wherein printer **100** conditions the signal appropriately into a form and level appropriate for powering the printer. Power may be received at one or more input pins **198** of port **196**.

Printer **100** may further include a data port **200** for transferring information between printer **100** and an external device (not shown). Data port **200** may be a parallel port and include a female receptacle **202** for coupling with a male receptacle **206** of a connector **204** of a parallel port cable **208** such that data may be transferred between printer **100** and an external device. In one embodiment of printer **100**, parallel port **200** is in compliance with a Centronics parallel interface standard, a standard for parallel data exchange between computers and peripheral devices such as printer **100**. As can be seen in FIG. **6**, printer **100** includes slots **152** for receiving tabs **138** and **140** as shown in FIGS. **2** and **3**.

Referring now to FIG. **7**, the internal mechanisms of a printer of the present invention will be discussed. Top cover **108** of printer **100** opens to expose the internal mechanisms of printer **100**. A keypad aperture **214** is formed in top cover **108** to provide access and viewability of keypad and display **112** when top cover **108** is in a closed position. Printer **100** includes a paper feed mechanism for feeding paper through printer **100**. As paper is fed through printer **100** with paper feed mechanism **210**, a printing mechanism **212** prints characters received as printing data sent to printer **100** via data port **200** onto the paper.

Referring now to FIG. **8**, a portable printing system in accordance with the present invention will be discussed. The portable printing system **800** includes printer **100** of FIG. **1** and a frame **810** to which printer **100** is mounted for portable use thereof. Frame **810** includes a handle **812** at one end for allowing user to pick up and carry portable printing system **800**. Frame **810** further includes a receptacle **814** for receiving a portable electronic data terminal (not shown) to be used in conjunction with printer **100**. Receptacle **814** includes a connector **816** for electrically coupling the portable electronic data terminal with printer **100**. A power supply foot **818** is attached at an end of frame **810** opposite to handle **812**. Power supply foot **818** contains a power supply for supplying operating power to printer **100** and to a data terminal when disposed in receptacle **814** via connector **816**. Power supply foot **818** includes a power cord receptacle **820** for receiving an end of a power cable (as shown in FIG. **9**) to connect printing system **800** to a power source such as a power outlet from a wall socket or from vehicle power. While printing system is being transported during portable use, the power cable may be stowed behind a cover **822** that opens upon actuation of cover latch **824** to an open position **826**.

Referring now to FIG. **9**, a power supply foot assembly for a portable printing system in accordance with the present invention will be discussed. The power supply foot assembly **900** includes a power supply foot **818** that preferably comprises a strong, durable and lightweight material having a relatively high thermal conductivity such as aluminum. Power supply foot **818** includes a first cavity **910** for stowing a power supply cord such as a non-coiled IEC compliant cable **912** or a coiled cable **914**, for example. An end plate **916** is disposed at one end of power supply foot **818** and includes an aperture for receiving IEC receptacle **820** having cabling **920** for connecting power to the power supply circuit **932** of power supply foot **818**. Power supply cable may be temporarily removed from receptacle **820** for stowage in cavity **910**. Power cable **914** may be permanently connected to power supply circuit **932** via cabling **922**. When power cable **914** is connected to an power source an aperture **926** in foot cover **822** may power cable to extend from power supply foot **818** with cable end **924** passing through aperture **926** while cover **822** is in a closed position. Power supply foot includes a second cavity **930** for receiving power supply circuit **932**. A second end plate **928** covers cavities **914** and **930** at the end of power supply foot **818** opposite to end plate **916**.

Referring now to FIGS. **10** and **11**, a power supply circuit assembly in accordance with the present invention will be discussed. Power supply foot **818** includes a power supply circuit **932** mounted therein for conditioning power received from an external ac power source via cable **912** or cable **914**. As shown in FIG. **10**, cable **914** may be stowed in cavity **910** of power supply foot **818**. Power supply circuit **932** includes a magnetic element that may be a toroidal inductor **1012** as shown. Inductor **1012** is bound one side by a spacer **1014**. A fastener **1016** connects inductor **1012** and spacer **1014** to a mounting bracket **1010**. Fastener **1016** further passes through and fastens a cover **1018** to bracket **1010** opposite to inductor **1012**. Cover **1018** contains electronic components **1110** and **1112** which are power conditioning components that typically generate heat during use which should be dissipated, for example voltage regulators. Components **1110** and **1112** are in physical contact with bracket **1010** via silicone pads **1114** and **1116**. Bracket **1010** is in turn

mounted to side walls **1118** and **1120** of power supply circuit **932** via fasteners **1122** and **1124**. Heat generated by components **1110** and **1112** is conducted through silicone pads **1114** and **1116** to bracket **1010**. The heat received by bracket **1010** is further conducted to side walls **1118** and **1120**.

Referring now to FIG. **12**, the electronic hardware components of a portable electronic printer of the present invention will be discussed. The hardware components **1200** generally include a printer control system **1228** coupled to a power supply system **1220**, and an input/output (I/O) system **1218** coupled to printer control system **1228** via power supply system **1220**. I/O system **1218** controls the transfer of data between printer **100** and an external device or a user. I/O system **1218** utilizes peripheral subsystems that provide an interface for information transfer. For example, I/O system **1218** couples to an infrared (IR) subsystem **1210** for infrared spectrum data communication which preferably conforms to a standard promulgated by the Infrared Data Association (IrDA). I/O system **1218** further couples to a transistor-transistor logic (TTL) subsystem **1212** for communicating with devices having TTL type circuits (e.g., bipolar transistors directly coupled or coupled through resistors). Additionally, I/O system **1218** couples to a serial port subsystem **1214** for serial data communications which preferably conforms to Recommended Standard 232 (RS-232) promulgated by the Electrical Industries Association (EIA), and to a parallel port subsystem **1216** for parallel data transfer which preferably conforms to a Centronics standard.

Power supply **1220** may receive electrical power for operating hardware components **1200** and additional power utilizing mechanisms of printer **100** from one or more available power sources. For example, power supply system **1220** may receive dc power from an ac/dc converter **1222** which converts an ac power input **1242** into dc power at a level utilizable by power supply system **1220**. Power supply system **1220** may also receive dc power directly from a battery **1224** disposed within printer housing **110** of printer **100**. Hardware system **1200** and printer **100** may receive operational power from battery **1224** during portable operation of printer **100**. For example, U.S. Pat. Nos. 5,347,115 and 5,484,991 disclose a portable modular work station including a printer an portable data collection terminal having a carrying handle attached to a side wall of a printer for portable use. Printer **100** of the present invention may be similarly adapted for portable operation as the printer disclosed in said patents. Said U.S. Pat. Nos. 5,347,115 and 5,484,991 are hereby incorporated by reference in their entireties. In such a portable utilization of printer **100**, power supply system **1220** may function as a self-contained power source as disclosed in U.S. Pat. No. 5,186,558 which is hereby incorporated by reference in its entirety. In another mode of operation of printer **100**, power supply system **1220** receives power from a dc power source **844** such as the system power of a vehicle in which printer **100** is utilized.

Printer control system **1228** couples with keyboard and display **1226** which functions as the control system of keyboard and display **112** of FIG. **1**. Printer control system **1228** additionally couples to an RJ-11 jack **1236** for coupling and communicating with an external device. Printer control system **1228** controls a paper feed motor **1238** that drives paper feeding mechanism **210**, and further controls a carriage motor **1246** and a print head motor **1240** that respectively drives and actuates printing mechanism **212** shown in FIG. **7**. Home detect hardware **1230** detects when paper fed into printer **100** is in a home, or beginning, position. Paper information hardware **1232** detects the presence and type of paper fed into printer **100**. Timing control hardware **1234** sends a timing control signal to printer control system **1228** for synchronizing the operations of printer **100**.

Referring now to FIG. **13** a hardware system for a portable electronic printing system in accordance with the present invention will be discussed. The hardware system shown in FIG. **13** is generally representative of the hardware architecture of a computer hardware implemented system of the printer **100** of the present invention. A central processing system **1310** controls printer hardware system **1300**. Central processing system **1310** includes a central processing unit such as a microprocessor or microcontroller for executing programs, performing data manipulations and controlling the tasks of hardware system **1300**. Communication with the central processor **1310** is implemented through a local system bus **1316** for transferring information among the components of the hardware system **1300**. Bus **1316** may include a data channel for facilitating information transfer between storage and other peripheral components of the hardware system. Bus **1316** further provides the set of signals required for communication with the central processing system **1310** including a data bus, address bus, and control bus. Bus **1316** may comprise any state of the art bus architecture according to promulgated standards, for example industry standard architecture (ISA), extended industry standard architecture (EISA), Micro Channel Architecture (MCA), peripheral component interconnect (PCI) local bus, standards promulgated by the Institute of Electrical and Electronics Engineers (IEEE) including IEEE 488 general-purpose interface bus (GPIB), IEEE 696/S-100, and so on. Other components of the hardware system **1300** include flash memory **1312** and random access memory (RAM) **1314**. Random access memory **1314** provides storage of instructions and data for programs executing on the central processing system **1310**, and is typically semiconductor based memory such as dynamic random access memory (DRAM) and or static random access memory (SRAM). Flash memory **1312** provides storage of instructions and data that are loaded into RAM **1314** before execution. Flash memory **1312** is non-volatile memory that includes a boot block, diagnostic block, control program section, and a file system section. The file system section is utilized to maintain downloaded fonts and other types of data files. At least eight kilobytes of flash memory is available for storing downloaded fonts. The file system section of flash memory **1312** allows for new fonts or font updates to be downloaded and saved in flash memory. As a result, printer **100** is able to be modified for utilization Flash memory **1312** may alternatively comprise other types of semiconductor based memory such as read-only memory (ROM), programmable read-only memory (PROM) erasable programmable read-only memory (EPROM), electrically erasable read-only memory (EEPROM). Other types of memory devices are contemplated as well without departing from the scope of the present invention. Generally, printer control system **1228** of FIG. **12** may be considered to include central processing system **1310**, flash memory **1312**, random access memory **1314** and bus **1316** of FIG. **13**.

Hardware system **100** further includes an input/output (I/O) system **1318** for connecting to one or more I/O devices **1320**. Input/output system **1318** may comprise one or more controllers or adapters for providing interface functions between I/O device **1320**. For example, input/output device **1320** may comprise a serial port, parallel port, infrared port, network adapter, radio-frequency (RF) communications adapter, universal asynchronous receiver-transmitter (UART) port, etc., for interfacing between an external

device **1322**. Generally, I/O system **1218** of FIG. **12** may correspond to input/output system **1318** of FIG. **13**, and I/O device **1320** may correspond to any of the I/O devices shown in FIG. **12** (IR **1210**, TTL **1212**, RJ-11 **1236**, keyboard and display **1226**, etc.).

Input/output system **1318** and I/O device **1320** may provide or receive analog or digital signals for communication between hardware system **1300** of the present invention and additional external devices, networks, or information or data sources. Input/output system **1318** and I/O device **1320** preferably implement industry promulgated architecture standards, including Ethernet IEEE 802 standards (e.g., IEEE 802.3 for broadband and baseband networks, IEEE 802.3z for Gigabit Ethernet, IEEE 802.4 for token passing bus networks, IEEE 802.5 for token ring networks, IEEE 802.6 for metropolitan area networks, and so on), Fibre Channel, digital subscriber line (DSL), asymmetric digital subscriber line (ASDL), frame relay, asynchronous transfer mode (ATM), integrated digital services network (ISDN), personal communications services (PCS), transmission control protocol/Internet protocol (TCP/IP), serial line Internet protocol/point to point protocol (SLIP/PPP), and so on. It should be appreciated that modification or reconfiguration of the hardware system **1300** of FIG. **13** by one having ordinary skill in the art would not depart from the scope or the spirit of the present invention.

Referring now to FIG. **14**, a timing diagram for illustrating simultaneous dual motor control of a printer in accordance with the present invention will be discussed. Printer **100** is capable of allowing paper feed motor **1238** to operate during periods of operation of carriage motor **1246** and print head **1240**. As illustrated by the timing diagram **1400**, vertical axis **1402** represents relative motor velocity while horizontal axis **1404** represents time. Plot **1410** represents the velocity of carriage motor **1246** with respect to time, and plot **1412** represents the velocity of paper feed motor **1238** with respect to time. One period of carriage motor **1246** defined by plot **1410** may be described as follows: during period CAC, carriage motor **1246** is accelerating; during period CPT, carriage motor **1246** is operating at a constant velocity; during period CDEC, carriage motor **1246** is decelerating; and during period CH, carriage motor is in a hold state. The periods CAC, CPT, CDEC, and CH together define one period of the velocity of carriage motor **1246**. One period of paper feed motor **1238** defined by plot **1412** may be described as follows: during period PH, paper feed motor **1238** is in a hold state; during period PAC, paper feed motor **1238** is accelerating; during period PFT, paper feed motor **1238** is operating at a constant velocity; and during period PDEC, paper feed motor **1238** is decelerating. The periods PH, PAC, PFT, and PDEC together define one period of paper feed motor **1238**.

The block of time **1414** represents a period of time that may be considered print time. During print time **1414**, carriage motor **1246** is receiving a signal from printer control system **1228** causing carriage motor **1246** to move. During print time **1414**, carriage motor **1246** is accelerating (CAC), moving at a constant velocity (CPT), or decelerating (CDEC). The block of time **1416** represent a period of time that may be considered paper feed time. During paper feed time **1416**, paper feed motor **1238** is accelerating (PAC), moving at a constant velocity (PFT), or decelerating (PDEC). Print time **1418** represents a new block of print time. As can be seen from FIG. **14**, printer control system **1228** simultaneously controls both carriage motor **1246** and paper feed motor **1238** such that there is some overlap between print time **1414** and paper feed time **1416**, and between paper feed time **1416** and print time **1218**. Thus, while carriage motor **1246** is still in motion, movement of paper feed motor **1238** may be initiated. The overlapping of motion of carriage motor **1246** and paper feed motor **1238** provides a reduction in printing time for a given print job. It has been determined that the overlapping of motor motion may reduce the print speed from 90 seconds to 50 seconds for a predetermined printing job, thereby reducing printing time by approximately 44%.

In operation, overlapping motor control of the present invention as illustrated by timing diagram **1400** allows paper feed motor **1238** to be operating while carriage motor **1246** is operating at the same time. Paper feed motor **1238** advances paper while carriage motor **1246** is decelerating during period CDEC. Paper feed motor **1238** is not required to wait for carriage motor **1246** to completely stop for the paper to advance. The method for simultaneous motor control is controlled by printer control system **1228** that includes a processor for interpreting and executing control functions of printer control system **1228**. A direct memory address (DMA) channel is utilized to advance the paper with paper feed motor **1238**, and an interrupt mechanism is utilized to control carriage motor **1246**. The control and management of carriage motor **1246** and paper feed motor **1238** may be implemented by computer readable code, or software, executed by processing system **1310** of printer control system **1228**. Printing data may be received by hardware system **1200** of printer **100** via an external I/O interface of I/O system **1218**, such as parallel port **1216**, from a device connected to printer **100** such as a portable data terminal (not shown). The printing information is received by printer control system **1228** that converts the printing information into a series of motor inputs for carriage motor **1246** and paper feed motor **1238**. The motors respond to the motor inputs received from printer control system and move according to the motor input signals. The motion of the motors is plotted as motor velocity versus time as depicted in FIG. **14**.

In addition to information for controlling the movement of carriage motor **1246** and paper feed motor **1238**, printing information received from an external device also contains actual print data which contains the characters to be printed onto the paper. A print head **1240** disposed in the carriage controlled by carriage motor **1246** prints the print data onto the paper in a linear fashion as carriage motor **1246** across the paper at constant velocity. Thus, print head **1240** is actuated to print on the paper during the constant velocity period (CPT). Since it is normally not desired to be simultaneously feeding the paper while print head **1240** is printing print data onto the paper, the only restriction upon actuation of paper feed motor **1238** is that paper is not fed or advanced while print head **1240** is printing. Since the deceleration period CDEC of carriage motor **1246** occurs upon completion of print head **1240** printing an amount of print data, paper feed motor **1238** acceleration period PAC may occur simultaneously with the deceleration period CDEC of carriage motor **1246** as illustrated in FIG. **14**.

The relative timing between carriage motor velocity **1410** and paper feed motor velocity **1412** is based upon the motion of carriage motor **1246**. A determination is made regarding the amount of time required for paper feed motor **1238** to perform a paper feed. Deceleration time CDEC of carriage motor **1246** is overlapped with the acceleration time PAC of paper feed motor. If necessary, paper feed acceleration time PAC may extend into carriage hold time CH. Additionally, constant velocity periods (CPT and PFT) overlap with a hold period of the other motor (PH and CH), such that at least one motor is in motion at any given time.

Carriage motor **1246** and paper feed motor **838** are preferably stepper motors such that printer control system **1228** may control when in time and how much each motor steps. Time is the equation here. It is the equation of time. Carriage acceleration time PAC is always a constant and is a known quantity, only varying with the preselected printing speed. If a higher resolution is selected, printing occurs at a slower speed. Printing speed may vary from line to line, depending on what speed printer **100** is set to print each line. The higher the selected resolution, the slower printer **100** will print. For a given resolution, this is a fixed time. Printing time is an unknown until the data for each line is actually received at which point printing time may be determined since printing speed number of printing dots required to be printed for the selected resolution are known.

Paper feed time **1416** is based on line pitch. For example, paper feed motor may be selected to feed at one-eighth inch or one-sixth inch line increments. Paper feed time may be determined from the selected line pitch and line spacing. Print time **1414** is determined based upon the total number of characters to be printed and the selected resolution. If paper feed time FP plus T is greater than TC hold begin, plus C hold end, then C hold begin plus C hold end plus equals the difference of the two. That would account for the stretch. For print time, we have to know the rate, the resolution, and the number of characters. The number of characters is based upon whether this is at the beginning of a line or showing at the end of the line, or the characters are elite font or a pica font. While print head **1240** is printing during carriage motor constant velocity CPT, paper feed acceleration PAC cannot be initiated. Likewise, when paper feed motor **1238** is decelerating during period PDEC, print head **1240** cannot be printing, that is carriage motor constant velocity period CPT cannot occur, however all the other events may occur. The only exclusion is that you can't actually be putting dots on paper while you are paper feeding. Thus, paper feed motor hold time PH is adjusted to accommodate carriage motor constant velocity time CPT (i.e., the time during which print head **1240** is printing). Additionally, the carriage motor hold time CH is adjusted to accommodate paper feed time. Print time and paper feed time are determined from incoming print data as printer **100** receives the print data.

Referring now to FIG. **15**, a flow diagram illustrating a method of operation of the printing control system in accordance with the present invention will be discussed. During implementation of method **1500**, printer **100** receives print data from an external device at step **1510**. The required printing time and paper feed time to print the received print data and to feed the paper through printer **100** are determined at steps **1512** and **1514**, respectively. A determination is made at step **1516** whether the carriage hold time CH is sufficient to accommodate the printer feed time PFT by determining whether carriage hold time CH is less than printer feed time PFT. If carriage hold time CH is less than printer feed time PFT, then carriage hold time is set, or stretched, to equal printer feed time PFT at step **1522**. A determination is made at step **1518** whether paper feed hold time PH is sufficient to accommodate carriage acceleration time CAC and carriage printing time CPT by determining whether paper feed hold time PH is less than the sum of carriage acceleration time CAC and carriage printing time CPT. If paper feed hold time PH is less than the sum of carriage acceleration time CAC and carriage printing time CPT, then paper feed hold time PH is set, or stretched, to equal the sum of carriage acceleration time CAC and carriage printing time CPT at step **1524**. Finally, the received print data is printed at step **1520**.

Referring now to FIG. **16**, a method for controlling and for canceling a printing operation of the printing system of the present invention will be discussed. The printing control method **1600** is implemented by printer control system **1228** of FIG. **12** using a serial printing interface. Printing control method **1600** begins at step **1610**, and printer control system **1228** receives print data to be printed at step **1614**. Print data includes a print header provides information to printing control system **1228** regarding action should be executed with the received print data. The print data header is read at step **1614**. A determination is made at step **1616** based upon the print data header whether printing should be canceled. If the print data header does not indicate that printing should be canceled, the print data is sent to a buffer at step **1618**. Print data accumulated in the buffer is printed at step **1620**. Printer control system **1228** continues to receive print data as it is accumulated in the buffer so long as the print header of received print data does not indicate that printing should be canceled. The print data is printed from the buffer on a first-in, first-out (FIFO) basis such that print data is printed from the buffer in the order in which the print data is received.

In the event that the print data header indicates that printing should be canceled, data accumulated in the buffer is dumped from the buffer at step **1622**, thereby canceling the printing of the data in the buffer at step **1624**. Since the print cancel command of the print data header is read at step **1616** prior to being sent to the buffer at step **1618**, the print cancel command is executed at step **1622** prior to the print data being sent to the buffer rather than after being held in the buffer. Thus, method **1600** effectively places the print cancel command at the head of the printing queue, and printer control system **1228** may cancel printing immediately without having to print all of the data in the buffer prior to canceling printing.

Referring now to FIG. **17**, a method for loading updated code or data into the printing system of the present invention will be discussed. The method **1700** initiates with the printer **100** being reset at step **1710**. The boot block of flash memory **1312** is mapped to logical address 0x0 at step **1712**. Boot block code is executed at step **1714**. The printer control program is loaded from flash memory **1312** to RAM **1314** at step **1716**. The control program is mapped to logical address 0x0 at step **1718**. A determination is made whether there is an update for code or data stored in flash memory **1312**. The updated code or data may be new boot block code, new diagnostic block code, new control program code, or new file system files such as font and character set data, for example. The updated code or data may be received by printer control system **1228** via I/O system **1218** or RJ-11 port **1236** for from an external device, host computer, communication link or network, for example. If there is an update for code or data, the updated code or data is loaded into flash memory at step **1726**, and the system is reset at step **1710**. If there is no update for code or data, the contents of flash memory are mapped to an available logical address beyond the end of the program code logical address, for example to address 0x80000, at step **1722**. The control program is executed from RAM **1314** at step **1724**.

Referring now to FIG. **18**, a method for verifying updated code or data loaded into the printing system in accordance with the present invention will be discussed. The verification method **1800** is initiated upon printer **100** downloading a file for storage in flash memory **1312**. A module format specification is included within the contents of the file itself. The module format specification includes the name of the file, the file version, the length of the file, and the cyclical

redundancy check (CRC) value for the complete file. Printer control system **1228** reads the module format specification of the downloaded file at step **1812**. A determination is made at step **1814** whether the filename in the module formation specification matches the file intended to have been downloaded. If the filename is determined to be incorrect, then printer **100** enters into a diagnostic mode at step **1826**. A determination is made at step **1816** whether the file version in the module formation specification matches the version intended to have been downloaded. If the version is determined to be incorrect, then printer **100** enters into a diagnostic mode at step **1826**. A determination is made at step **1818** whether the file length in the module formation specification matches the length intended to have been downloaded. If the length is determined to be incorrect, then printer **100** enters into a diagnostic mode at step **1826**. A cyclical redundancy check is performed on the file as downloaded at step **1820**. A determination is made at step **1822** whether the CRC value in the module formation specification matches the CRC value resulting from step **1820**. If the CRC value in the module formation specification does not match the CRC value resulting from step **1820**, then printer **100** enters into a diagnostic mode at step **1826**. If all tests of the information of the module format specification are verified, then the updated file is determined to be good, and the completeness of file download is verified at step **1824**. If at test of the information of the module format specification is not verified, a diagnostic mode is entered into at step **1826**, and the file is downloaded again at step **1810**.

Referring to FIG. **19**, a method for automatically determining the communication protocol for data received by the printer of the present invention will be discussed. The method **1900** initiates upon printer control system **1228** receiving data from an external device via I/O system **1218**. An interface indication signal is received at step **1910** that indicates to printer control system **1228** the communications protocol and interface utilized for the transmission of the data. The interface indication signal may be an analog signal whose value continuously varies from over a range of values. The interface indication signal is converted to a digital value readable by printer control system **1228** at step **1912**. For example, the interface indication signal may be converted from an analog value to a digital value using an analog-to-digital converter implemented by printer control system **1228**. The value of the interface indication signal may then be determined. If the value of the interface indication signal is determined to be on the order of a first value, for example 0.0 volts, at step **1914**, then it is determined that a first communication protocol is utilized, for example infrared (IrDA), at step **1920**. If the value of the interface indication signal is determined to be on the order of a second value, for example 2.5 volts, at step **1916**, then it is determined that a second communication protocol is utilized, for example parallel data communications, at step **1922**. If the value of the interface indication signal is determined to be on the order of a third value, for example 5.0 volts, at step **1918**, then it is determined that a third communication protocol is utilized, for example serial data communications, at step **1924**. If it the value of the interface indication signal is not determined, or not within a predetermined range, then receipt of the interface indication signal is repeated at step **1912** until a valid value is determined.

Referring now to FIG. **20**, a method for controlling communication during a diagnostics mode will be discussed. The method **2000** is initiated upon printer **100** entering into a diagnostic mode at step **2010**. A reset signal is applied to all subsystems at step **2014**, thereby preventing devices from communicating with printer control system **1228** via I/O system **1218**. An external diagnostic performing device is capable of directly communicating with printer control system **1228** via RJ-11 port **1236** without any interference from an external device via I/O system **1218**. While the external device is performing diagnostic routines upon printer control system **1228** as determined at step **2018**, application of the reset signal is maintained at step **2014**. Upon completion of the diagnostic routines, application of the reset signal to the printer subsystems is terminated at step **2020**. Thus, method **2000** allows for direct communication with printer control system **1228** by an external device during diagnostics via RJ-11 port **1236** rather than via I/O system **1218**. With I/O system **1218** shut down, no other device is capable of inadvertently communicating with printer control system **1228** and interfering with the diagnostic routines.

Referring now to FIG. **21**, a method of operation of a printing system in accordance with the present invention is illustrated by a flow diagram. A print system in accordance with the embodiment of FIG. **21** first measures at least one external condition, (step **2102**) of the print system. It is understood that the external condition could be anything that affects the operation of the print system. For instance, the external condition could be the composition or thickness of the print media used in the print system. In a preferred embodiment, however, the external condition is an environmental condition at the locality of the print system. For instance, the external condition could be the environmental temperature, barometric pressure, atmospheric pressure, dew point, or any other climatic condition that might affect the operation of the printer system. In a presently most preferred embodiment, the environmental condition is the temperature at the locality of the printer system, but it should be emphasized that with knowledge of this disclosure, other external conditions which affect the operation of a printer system will become apparent to one with ordinary skill in the art. Such external conditions are within the spirit and scope of this disclosure.

Once the external condition (e.g. the temperature) has been measured in step **2102**, the print settings or printer operating conditions are set according to the measured external condition (step **2104**). Examples of print settings that might be available in accordance with the present invention include the settings for any printing function that is affected by the measured external condition in step **2102**. By way of example and not limitation, the print settings might be the temperature of operation of the printing system or the impact force of a contact printer. In a preferred embodiment, the print setting that is set in step **2104** is the print impact force of a contact printer.

The print system may utilize computer circuitry to properly determine the correct setting of step **2104** based on the measured data of step **2102**. By way of example and not limitation, the printer system may use a table which equates external conditions to proper print settings. The table may be created by theoretical calculations known in the art, or experimentally.

Once the print settings are set in step **2104**, the print time is set in accordance with the print settings (step **2106**). The goal is to substantially minimize the print time for every given print setting. Again, tables (created either theoretically or experimentally) or mathematical equations can be used to determine the minimum print time in step **2106** from the setting of step **2104** and the input print data. Based on the input print data and the print time, the paper feed time is set.

Reference is made to FIG. **14** where, by way of example, the paper feed time (PFT) may be selected, and paper hold time (PH) may be set such that PH=CAC+CPT. It should be noted that in this example of FIG. **14**, the printer will operate with overlapping of print drive times **1414** and paper feed times **1416** with CH somewhat greater than PFT or with PH somewhat greater than CAC+CPT. Thus, deviations from the preferred equalities are within the scope of this disclosure. However, print speed is maximized in accordance with the present invention when CH=PFT and PH=CAC+CPT.

Referring now to FIG. **22**, another method of operation of a printing system in accordance with the present invention is illustrated by a flow diagram. In the embodiment of FIG. **22**, the printer system is preset to the desired print settings (step **2202**). This may take place by the manual data entry of an end user into either the printer system itself or a computer communicativley coupled to the printer system. The printer system then determines the print times (step **2204**) and determines paper feed times (step **2206**) according to the preset print settings. In steps **2204** and **2206**, either the print system or computer communicatively coupled thereto may utilize a table (created theoretically or experimentally) to determine the desired print time given the preset print settings and given input print data or to determine the desired paper feed time from the given the print time.

To minimize the print time, the printer system or a computer communicatively coupled thereto compares CH to PFT (see FIG. **14**). The printer will operate as long as CH>PFT; thus, deviations from the preferred equalities are within the scope of this disclosure. However, print speed is maximized in accordance with the present invention when CH=PFT. Maximization of print speed is effectuated in steps **2208** and **2210**.

To further minimize print time, the printer system or a computer communicatively coupled thereto compares PH to CAC+CPT (see FIG. 14). Again, the printer will operate as long as PH>CAC+CPT; thus, deviations from the preferred equalities are within the scope of this disclosure. However, print speed is maximized in accordance with the present invention when PH=CAC+CPT. Maximization of print speed is effectuated in steps **2212** and **2214**.

Referring now to FIG. **23**, another method of operation of a printing system in accordance with the present invention is illustrated by a flow diagram. In the embodiment of FIG. **23** environmental conditions are measured in step **2302** by either circuitry in the printer or a computer communicatively coupled thereto. The print settings are then automatically adjusted in step **2304**. Steps **2306–2318** are exactly the same as steps **2204–2216** of FIG. **22**.

It is believed that the control system and method for a portable electronic printer of the present invention and many of its attendant advantages will be understood by the forgoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the components thereof without departing from the scope and spirit of the invention or without sacrificing all of its material advantages, the form herein before described being merely an explanatory embodiment thereof. It is the intention of the following claims to encompass and include such changes.

What is claimed is:

1. In a printer system, a method of substantially maximizing print quality comprising at least the following steps:

a) measuring at least one external condition at the printer locality;

b) setting the printer with at least one substantially optimal printer operating condition according to said measured external condition; and

c) setting a print time control to achieve substantially minimal acceptable print time for the printer at said substantially optimal printer operating condition.

2. A method as in claim **1** wherein the external condition is an environmental condition from the group of environmental conditions comprising: Temperature, Barometric Pressure, Atmospheric Pressure, and Dew Point.

3. A method as in claim **1** wherein the external condition is measured by an end user.

4. A method as in claim **1** wherein the external condition is measured by a computer communicatively coupled to the printer system.

5. A method as in claim **1** wherein the external condition is measured by the printer system.

6. A method as in claim **1** wherein the printer system is a printer from the group of printers comprising: a contact printer, a dot matrix printer, an ink jet printer, and a laser printer.

7. A method as in claim **1** wherein the printer operating condition is an operating condition from the group of operating conditions comprising: printer impact force, printer temperature of operation, and printer power consumption.

8. In a printer system, a method of substantially maximizing print quality and substantially minimizing print time comprising at least the following steps:

a) measuring at least one external condition at the printer locality,

b) setting the printer with at least one substantially optimal printer operating condition according to said measured external condition,

c) setting a print time control to achieve substantially minimal acceptable print time for the printer at said substantially optimal printer operating condition, and

d) setting a paper feed time control to achieve substantially minimum acceptable paper feed time at the setting of the print time control for given input print data.

9. A method as in claim **8** wherein the external condition is an environmental condition from the group of environmental conditions comprising: Temperature, Barometric Pressure, Atmospheric Pressure, and Dew Point.

10. A method as in claim **8** wherein the external condition is measured manually by an end user.

11. A method as in claim **8** wherein the external condition is measured by a computer communicatively coupled to the printer system.

12. A method as in claim **8** wherein the external condition is measured by the printer system.

13. A method as in claim **8** wherein the printer system is a printer from the group of printers comprising: a contact printer, a dot matrix printer, an ink jet printer, and a laser printer.

14. A method as in claim **8** wherein the printer operating condition is an operating condition from the group of operating conditions comprising: printer impact force, printer temperature of operation, and printer power consumption.

15. In a printer system, a method of substantially maximizing print quality and substantially minimizing print time, comprising at least the following steps:

a) measuring an environmental condition at the printer locality,

b) setting the printer at a substantially optimal printer operating condition according to said measured environmental condition, and

c) setting a print time control to achieve substantially minimal acceptable print time for the printer at said substantially optimal printer operating condition, and setting a paper feed time control to achieve substantially minimum acceptable paper feed time at the setting of the print time control, for given input print data,

wherein the settings of the paper feed time control and of the print time control are adjusted to result in substantial overlap of printing drive times and paper feed times.

16. A printing system, comprising:

printer housing;

a printing mechanism, located in said printer housing;

a paper feed mechanism;

a memory component storing a printer configuration computer program; and

a printer control system communicatively coupled with said printing mechanism, said paper feed mechanism, and said memory component;

wherein said printer configuration computer program comprises instructions executable by said printer control system to configure a print time control setting a print time for said printing mechanism based on a condition existing externally of said printer mechanism.

17. The printing system of claim 16, further comprising an external condition sensing component.

18. The printing system of claim 17, wherein said external condition sensing component is communicatively coupled with said printer control system.

19. The printing system of claim 18, wherein said instructions of said printer configuration computer program cause configuration of the printing system to be based on a condition existing externally of said printer mechanism that is sensed by said external condition sensing component.

20. The printing system of claim 17, further comprising:

a user interface, communicatively coupled with said printer control system;

wherein said instructions of said printer configuration computer program cause configuration of the printing system to be based on an externally existing condition sensed by said external condition sensing component and input via said user interface.

21. The printing system of claim 17, wherein said external condition sensing component is located within said printer housing and wherein said external condition sensing component is communicatively coupled with said printer control system.

22. The printing system of claim 17, further comprising a communication system, said communication system communicatively coupled with said printer control system.

23. The printing system of claim 22, wherein said external condition sensing component is located externally of said printer housing and wherein said external condition sensing component is communicatively coupled with said printer control system via said communication system.

24. The printing system of claim 16, wherein said instructions of said printer configuration computer program cause configuration of the printing system to be based on an environmental condition existing externally of said printer mechanism.

25. The printing system of claim 24, wherein the environmental condition is temperature.

26. The printing system of claim 24, wherein the environmental condition is atmospheric pressure.

27. The printing system of claim 24, wherein the environmental condition is dew point.

28. The printing system of claim 24, wherein the environmental condition is a climatic condition.

29. The printing system of claim 16, wherein said instructions of said printer configuration computer program cause configuration of the printing system to be based on a plurality of environmental conditions existing externally of said printer mechanism.

30. The printing system of claim 16, wherein operation of said printing mechanism is adjusted via said printer control system and said printer configuration computer program based on a condition existing externally of said printer mechanism.

31. The printing system of claim 16, wherein an impact force parameter of said printing mechanism is set via said printer control system based on a condition existing externally of said printer mechanism.

32. The printing system of claim 16, wherein an operating temperature parameter of said printing mechanism is set via said printer control system based on a condition existing externally of said printer mechanism.

33. The printing system of claim 16, wherein said memory component further comprises a look-up table, and wherein said instructions of said printer configuration computer program cause said printer control system to reference the look-up table to determine a proper configuration of the printing system for the condition existing externally of said printer mechanism.

34. A printing system, comprising:

a printer housing;

a user interface;

a printing mechanism, located in said printer housing;

a paper feed mechanism;

an external condition sensing component;

a memory component storing a printer configuration computer program; and

a printer control system communicatively coupled with said user interface, said printing mechanism, said paper feed mechanism, said external condition sensing component, and said memory component;

wherein said printer configuration computer program comprises instructions executable by said printer control system to configure a print time control to set a print time for said printing mechanism based on an environmental condition sensed by said external condition sensing component.

35. A printing system, comprising:

means for housing a printing system;

means for printing, located in said means for housing;

means for feeding paper into said means for printing;

means for storing a printer configuration computer program; and

means for controlling, communicatively coupled with said means for printing, said means for feeding paper, and said means for storing;

wherein said printer configuration computer program comprises instructions executable by said means for controlling to configure a print time control to set a print time for said means for printing based on a condition existing externally of said means for printing.

* * * * *

US005832192A

United States Patent [19]

Hino

[11] Patent Number: 5,832,192

[45] Date of Patent: Nov. 3, 1998

[54] **PRINTER CONTROLLING APPARATUS AND METHOD AND RECORDING MEDIUM FOR RECORDING PROGRAM CODE FOR EXECUTING THE SAME**

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[21] Appl. No.: **678,482**

[22] Filed: **Jul. 9, 1996**

[30] **Foreign Application Priority Data**

Jul. 14, 1995 [JP] Japan 7-178710

[51] **Int. Cl.**[6] **G06K 15/00**

[52] **U.S. Cl.** **395/115**; 395/103

[58] **Field of Search** 395/101, 112, 395/113, 114, 115, 116, 103, 834, 836, 872, 874, 876, 877, 892, 894; 347/111, 142, 145; 358/450, 467, 443, 540, 530

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Primary Examiner—Arthur G. Evans

Attorney, Agent, or Firm—Fitzpatrick, Cella, Harper & Scinto

[57] **ABSTRACT**

A plurality of plotting data generated for image output by an application program of a host computer are subjected to buffering; it is determined whether or not the plurality of buffered plotting data can be described by a smaller number of plotting data; and, when determined as capable of being described by a smaller number of plotting data, the plurality of buffered plotting data are converted into a smaller number of plotting data.

21 Claims, 15 Drawing Sheets

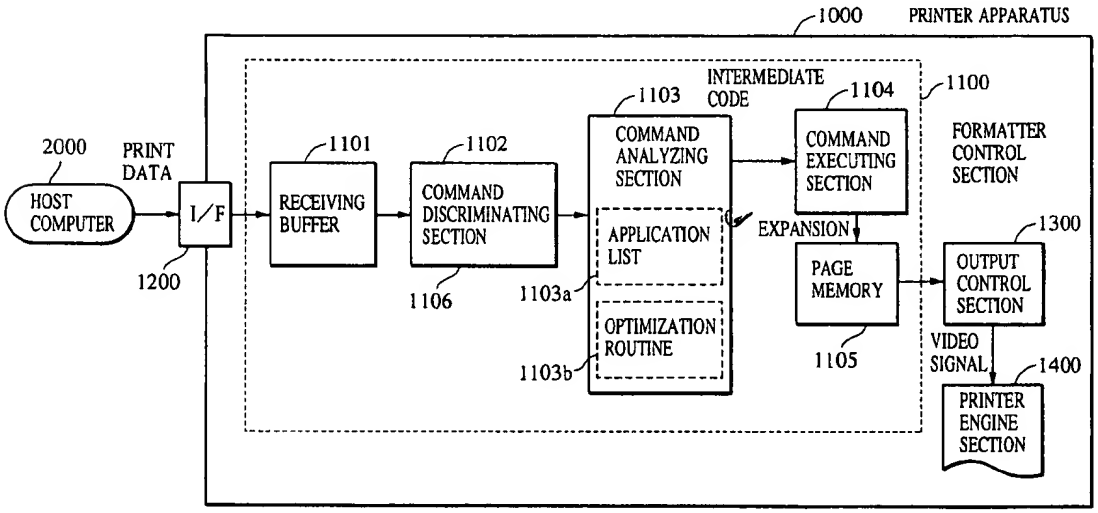


FIG. 1

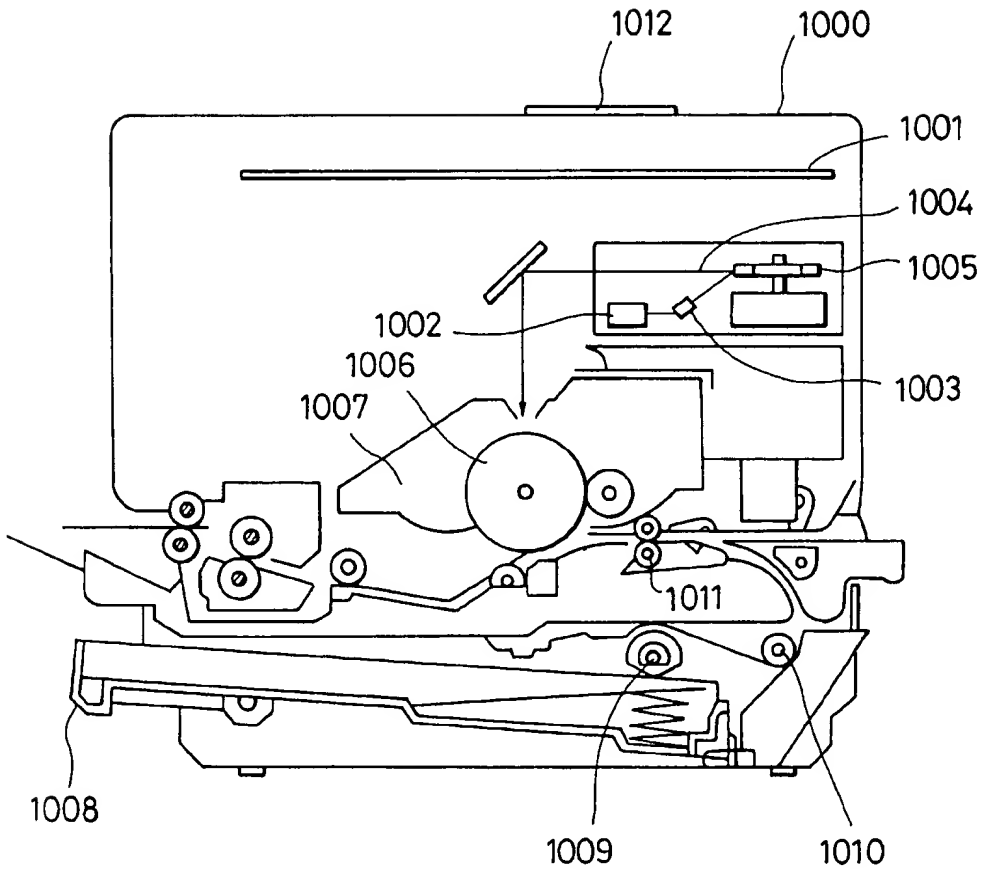

1012
1000
1001
1004
1005
1002
1006
1007
1003
1011
1008
1009
1010

FIG. 2

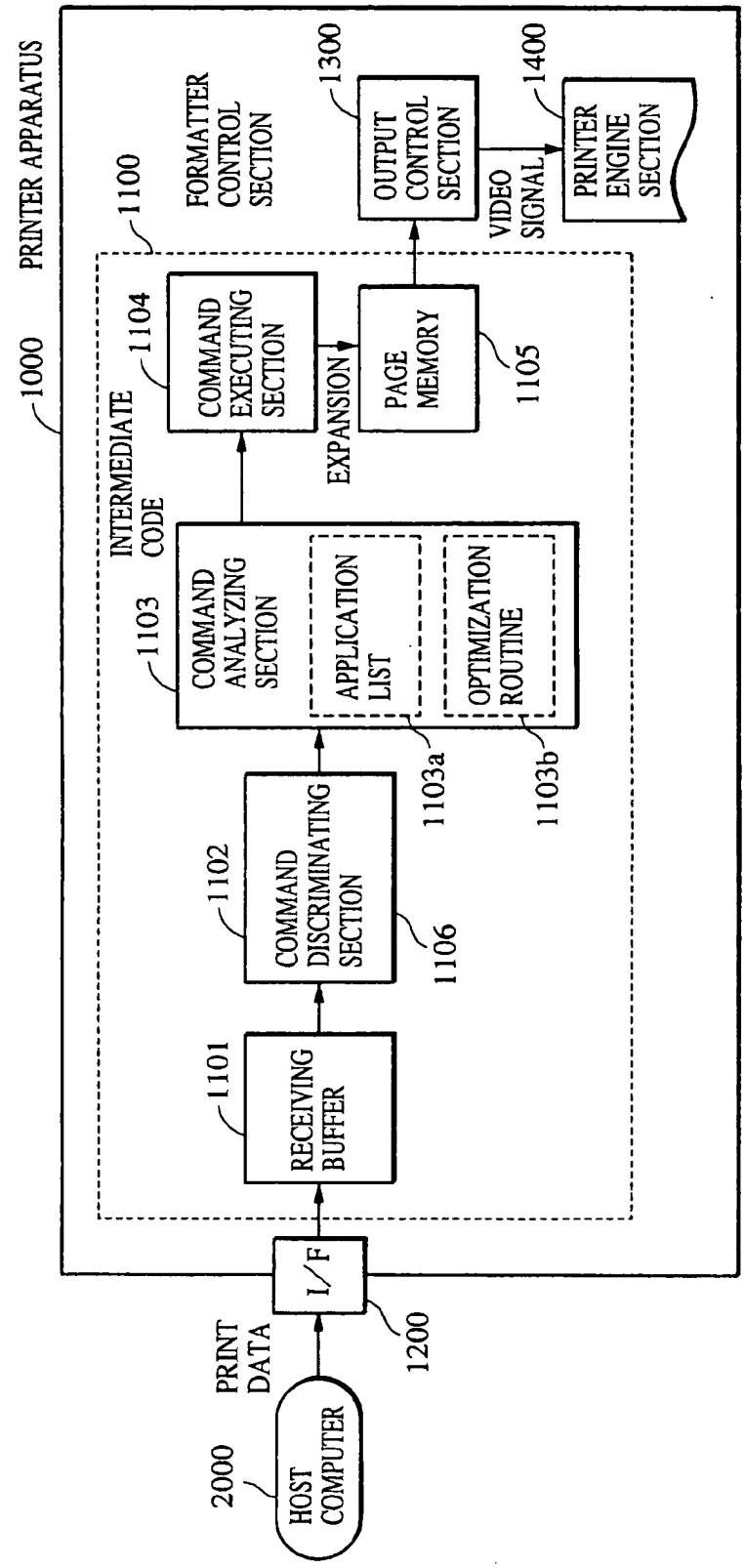

PRINTER APPARATUS
1000
FORMATTER CONTROL SECTION
1100
INTERMEDIATE CODE
OUTPUT CONTROL SECTION
1300
PRINTER ENGINE SECTION
1400
VIDEO SIGNAL
COMMAND EXECUTING SECTION
1104
EXPANSION
PAGE MEMORY
1105
COMMAND ANALYZING SECTION
1103
APPLICATION LIST
OPTIMIZATION ROUTINE
1103a
1103b
COMMAND DISCRIMINATING SECTION
1102
1106
RECEIVING BUFFER
1101
I/F
1200
PRINT DATA
HOST COMPUTER
2000

FIG. 3

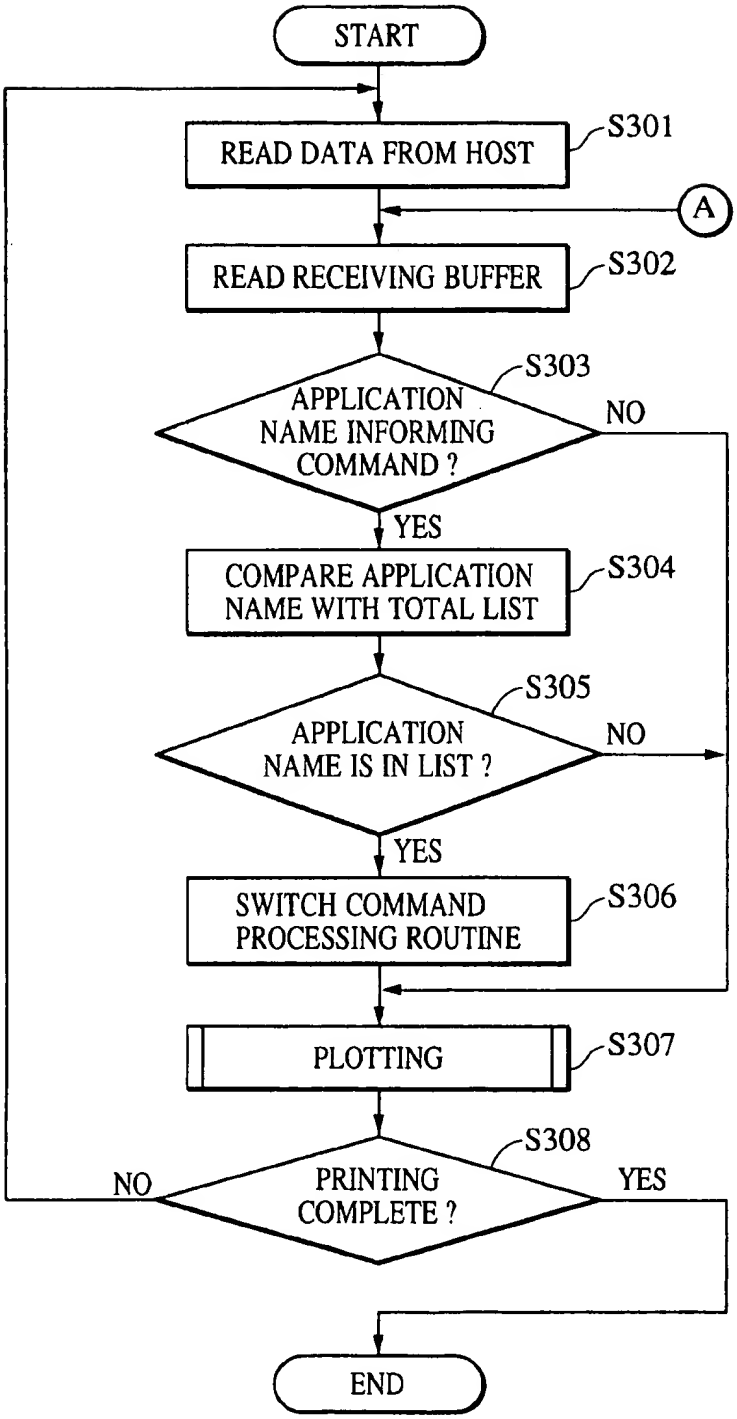

START
READ DATA FROM HOST
S301
A
READ RECEIVING BUFFER
S302
APPLICATION NAME INFORMING COMMAND ?
S303
NO
YES
COMPARE APPLICATION NAME WITH TOTAL LIST
S304
APPLICATION NAME IS IN LIST ?
S305
NO
YES
SWITCH COMMAND PROCESSING ROUTINE
S306
PLOTTING
S307
PRINTING COMPLETE ?
S308
NO
YES
END

FIG. 4

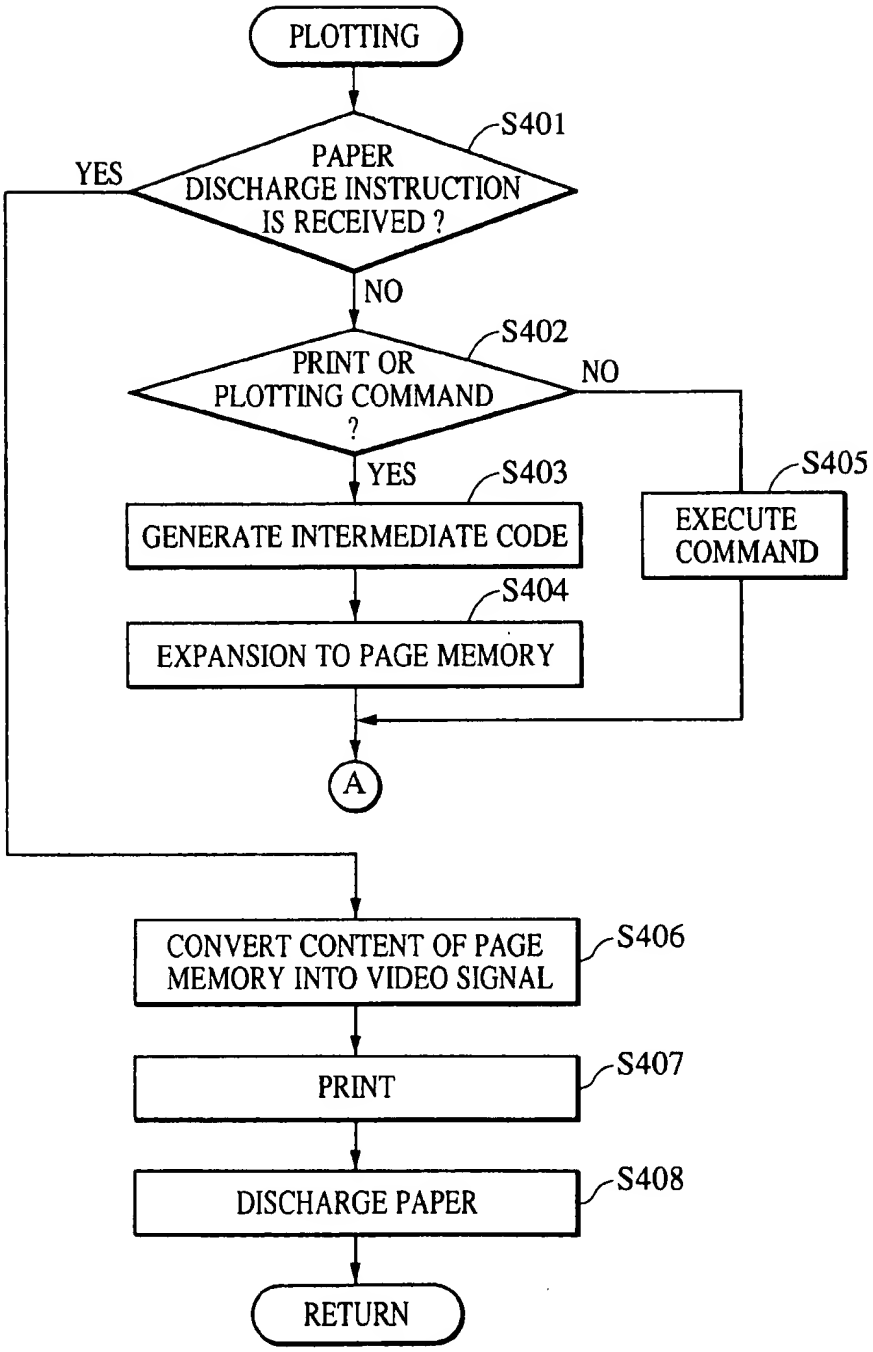
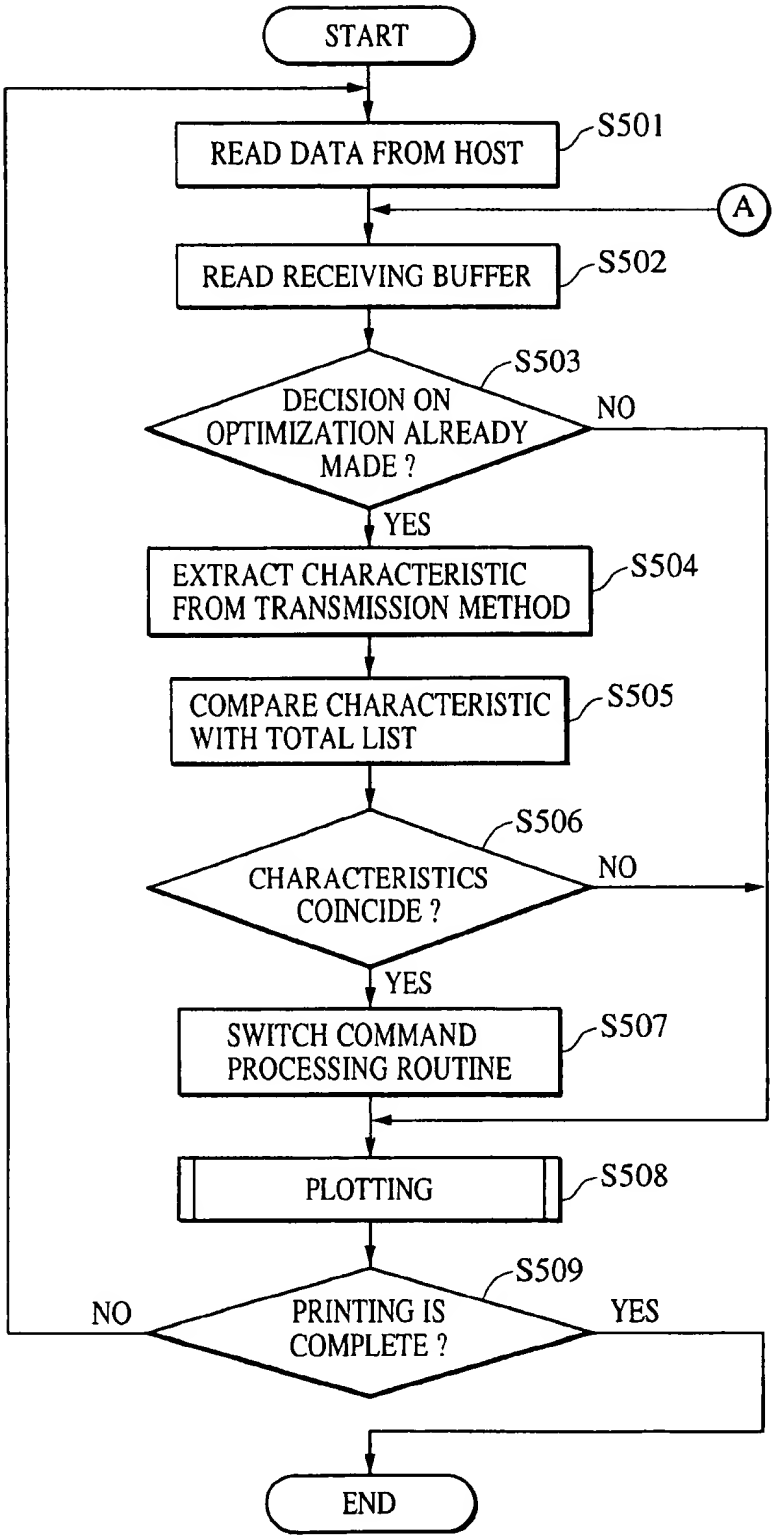

PLOTTING
S401
PAPER DISCHARGE INSTRUCTION IS RECEIVED ?
YES
NO
S402
PRINT OR PLOTTING COMMAND ?
NO
YES
S403
GENERATE INTERMEDIATE CODE
S404
EXPANSION TO PAGE MEMORY
S405
EXECUTE COMMAND
A
CONVERT CONTENT OF PAGE MEMORY INTO VIDEO SIGNAL
S406
PRINT
S407
DISCHARGE PAPER
S408
RETURN

FIG. 5


START
READ DATA FROM HOST
S501
A
READ RECEIVING BUFFER
S502
S503
DECISION ON OPTIMIZATION ALREADY MADE ?
NO
YES
EXTRACT CHARACTERISTIC FROM TRANSMISSION METHOD
S504
COMPARE CHARACTERISTIC WITH TOTAL LIST
S505
S506
CHARACTERISTICS COINCIDE ?
NO
YES
SWITCH COMMAND PROCESSING ROUTINE
S507
PLOTTING
S508
S509
NO
PRINTING IS COMPLETE ?
YES
END

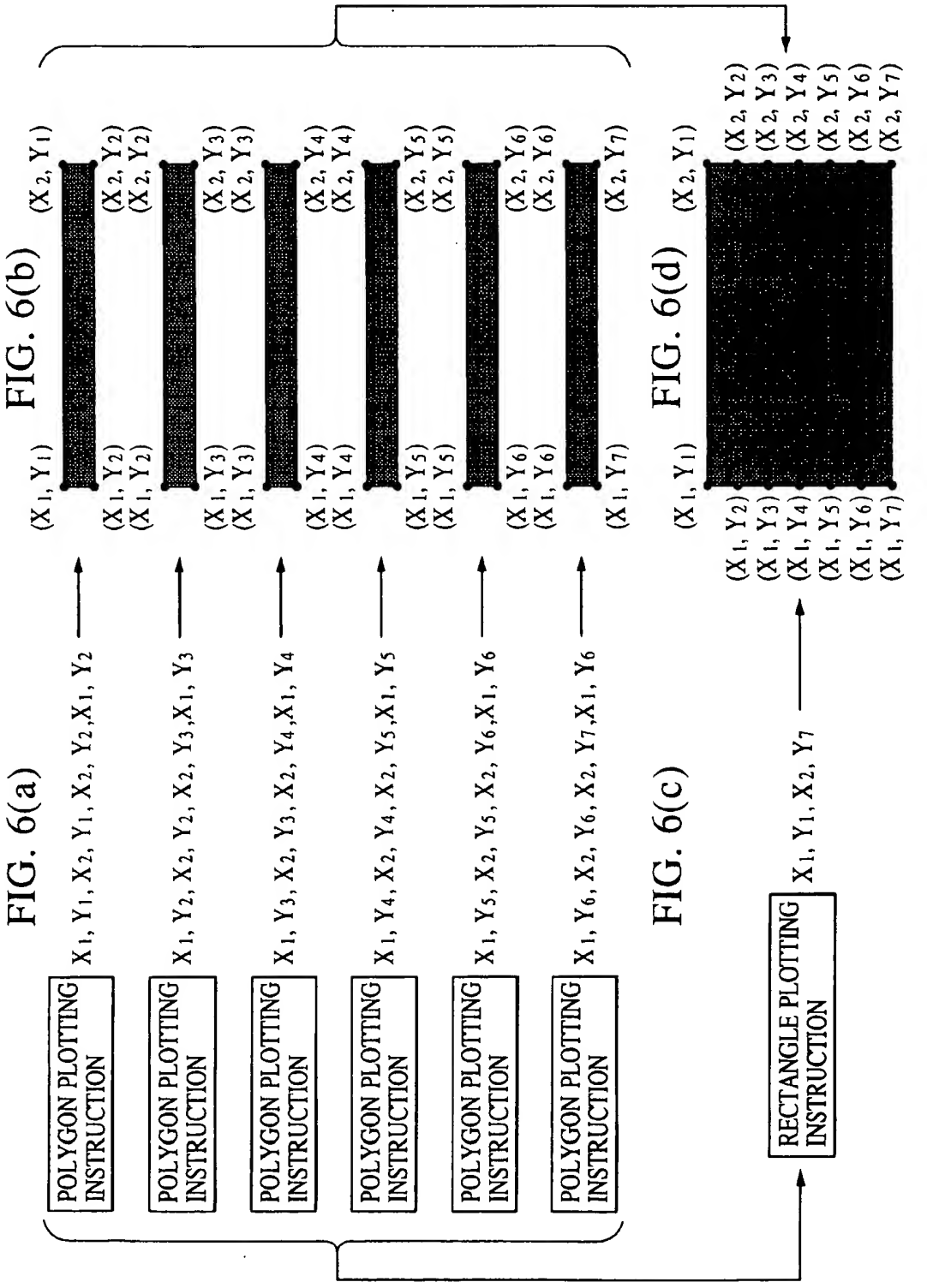


FIG. 6(a)
POLYGON PLOTTING INSTRUCTION
X1, Y1, X2, Y1, X2, Y2, X1, Y2
X1, Y2, X2, Y2, X2, Y3, X1, Y3
X1, Y3, X2, Y3, X2, Y4, X1, Y4
X1, Y4, X2, Y4, X2, Y5, X1, Y5
X1, Y5, X2, Y5, X2, Y6, X1, Y6
X1, Y6, X2, Y6, X2, Y7, X1, Y7
FIG. 6(b)
(X1, Y1) (X2, Y1)
(X1, Y2) (X2, Y2)
(X1, Y2) (X2, Y2)
(X1, Y3) (X2, Y3)
(X1, Y3) (X2, Y3)
(X1, Y4) (X2, Y4)
(X1, Y4) (X2, Y4)
(X1, Y5) (X2, Y5)
(X1, Y5) (X2, Y5)
(X1, Y6) (X2, Y6)
(X1, Y6) (X2, Y6)
(X1, Y7) (X2, Y7)
FIG. 6(c)
RECTANGLE PLOTTING INSTRUCTION
X1, Y1, X2, Y7
FIG. 6(d)
(X1, Y1) (X2, Y1)
(X1, Y2) (X2, Y2)
(X1, Y3) (X2, Y3)
(X1, Y4) (X2, Y4)
(X1, Y5) (X2, Y5)
(X1, Y6) (X2, Y6)
(X1, Y7) (X2, Y7)

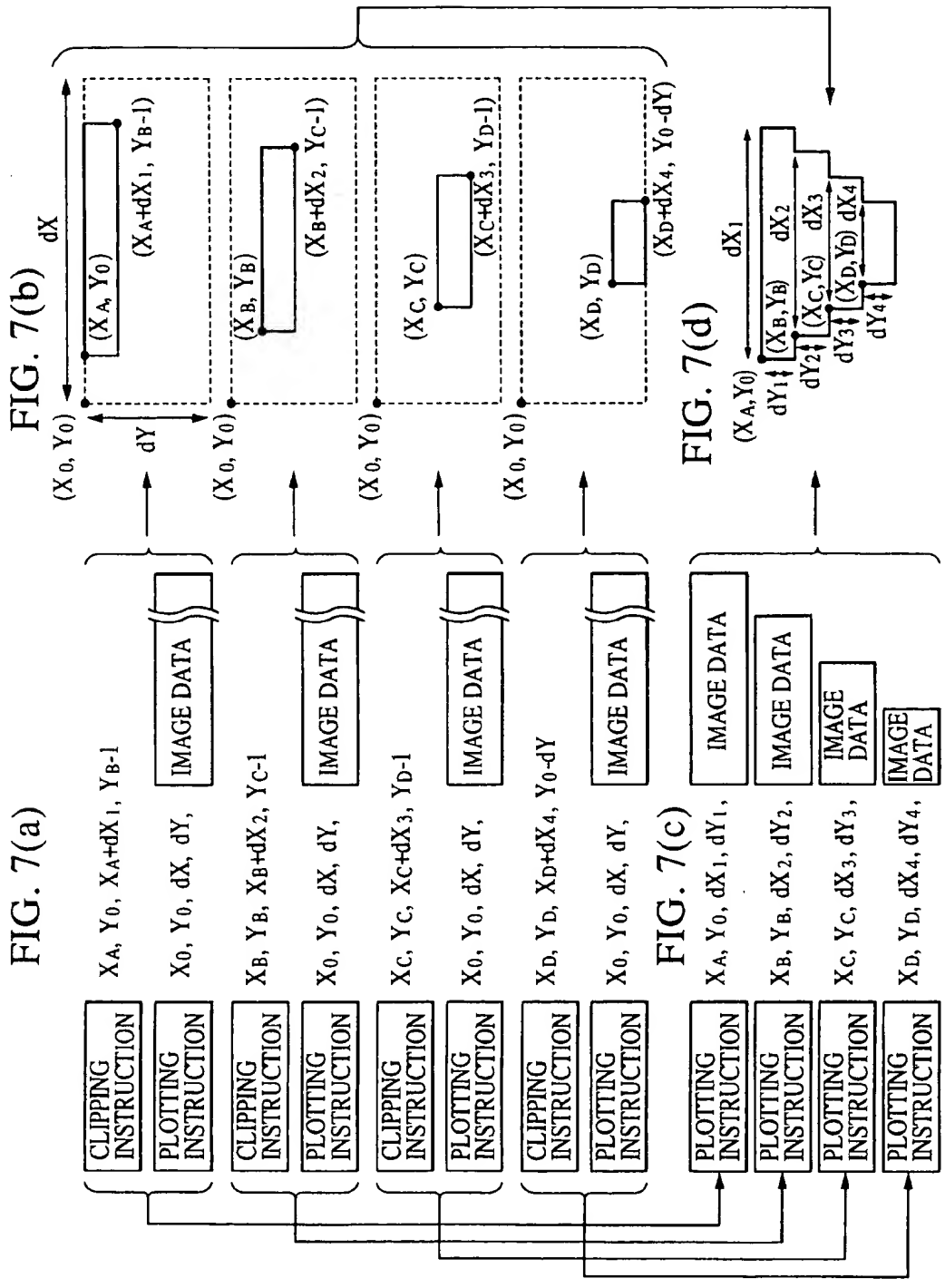


FIG. 7(a)
CLIPPING INSTRUCTION
PLOTTING INSTRUCTION
IMAGE DATA
$X_A, Y_0, X_A+dX_1, Y_B-1$
$X_0, Y_0, dX, dY,$
$X_B, Y_B, X_B+dX_2, Y_C-1$
$X_0, Y_0, dX, dY,$
$X_C, Y_C, X_C+dX_3, Y_D-1$
$X_0, Y_0, dX, dY,$
$X_D, Y_D, X_D+dX_4, Y_0-dY$
$X_0, Y_0, dX, dY,$
FIG. 7(b)
dX
dY
(X_0, Y_0)
(X_A, Y_0)
(X_A+dX_1, Y_B-1)
(X_B, Y_B)
(X_B+dX_2, Y_C-1)
(X_C, Y_C)
(X_C+dX_3, Y_D-1)
(X_D, Y_D)
(X_D+dX_4, Y_0-dY)
FIG. 7(c)
$X_A, Y_0, dX_1, dY_1,$
$X_B, Y_B, dX_2, dY_2,$
$X_C, Y_C, dX_3, dY_3,$
$X_D, Y_D, dX_4, dY_4,$
FIG. 7(d)
dX_1
(X_A, Y_0)
dY_1
(X_B, Y_B)
dX_2
dY_2
(X_C, Y_C)
dX_3
dY_3
(X_D, Y_D)
dX_4
dY_4

FIG. 8

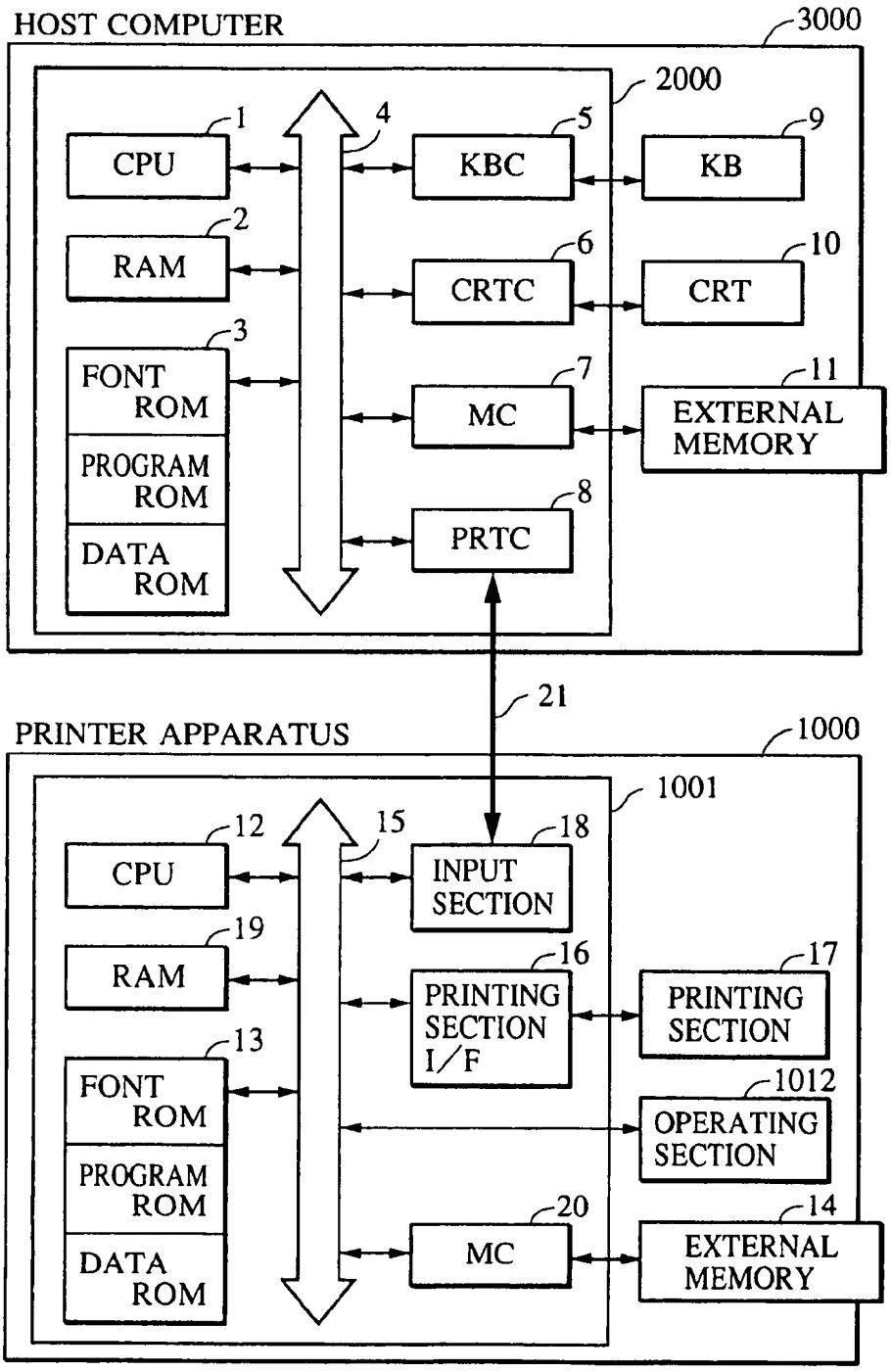
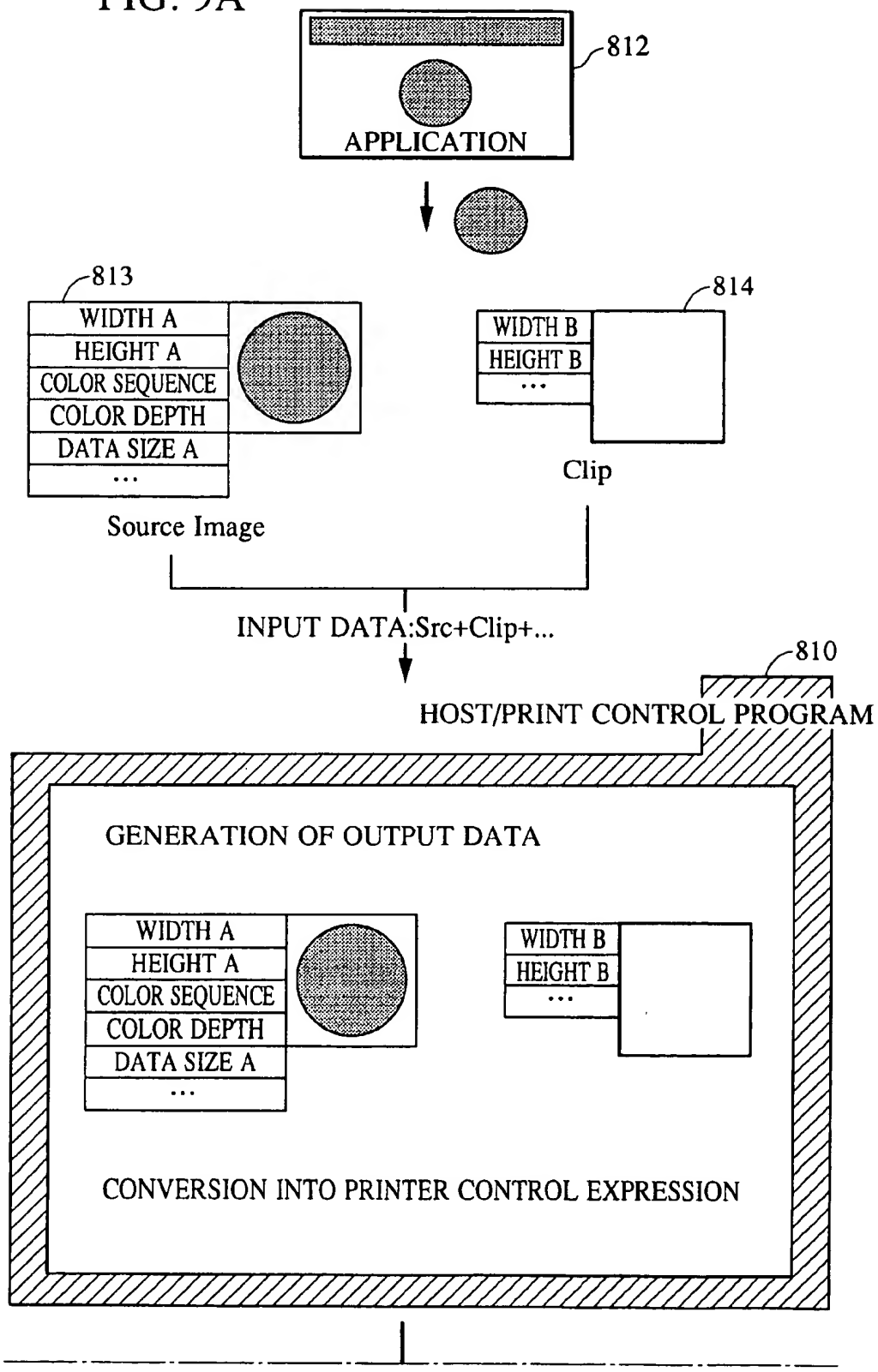

HOST COMPUTER
3000
2000
1
CPU
4
5
KBC
9
KB
2
RAM
6
CRTC
10
CRT
3
FONT ROM
PROGRAM ROM
DATA ROM
7
MC
11
EXTERNAL MEMORY
8
PRTC
21
PRINTER APPARATUS
1000
1001
12
CPU
15
18
INPUT SECTION
19
RAM
16
PRINTING SECTION I/F
17
PRINTING SECTION
13
FONT ROM
PROGRAM ROM
DATA ROM
1012
OPERATING SECTION
20
MC
14
EXTERNAL MEMORY

FIG. 9A


812
APPLICATION
813
WIDTH A
HEIGHT A
COLOR SEQUENCE
COLOR DEPTH
DATA SIZE A
...
Source Image
814
WIDTH B
HEIGHT B
...
Clip
INPUT DATA:Src+Clip+...
810
HOST/PRINT CONTROL PROGRAM
GENERATION OF OUTPUT DATA
WIDTH A
HEIGHT A
COLOR SEQUENCE
COLOR DEPTH
DATA SIZE A
...
WIDTH B
HEIGHT B
...
CONVERSION INTO PRINTER CONTROL EXPRESSION

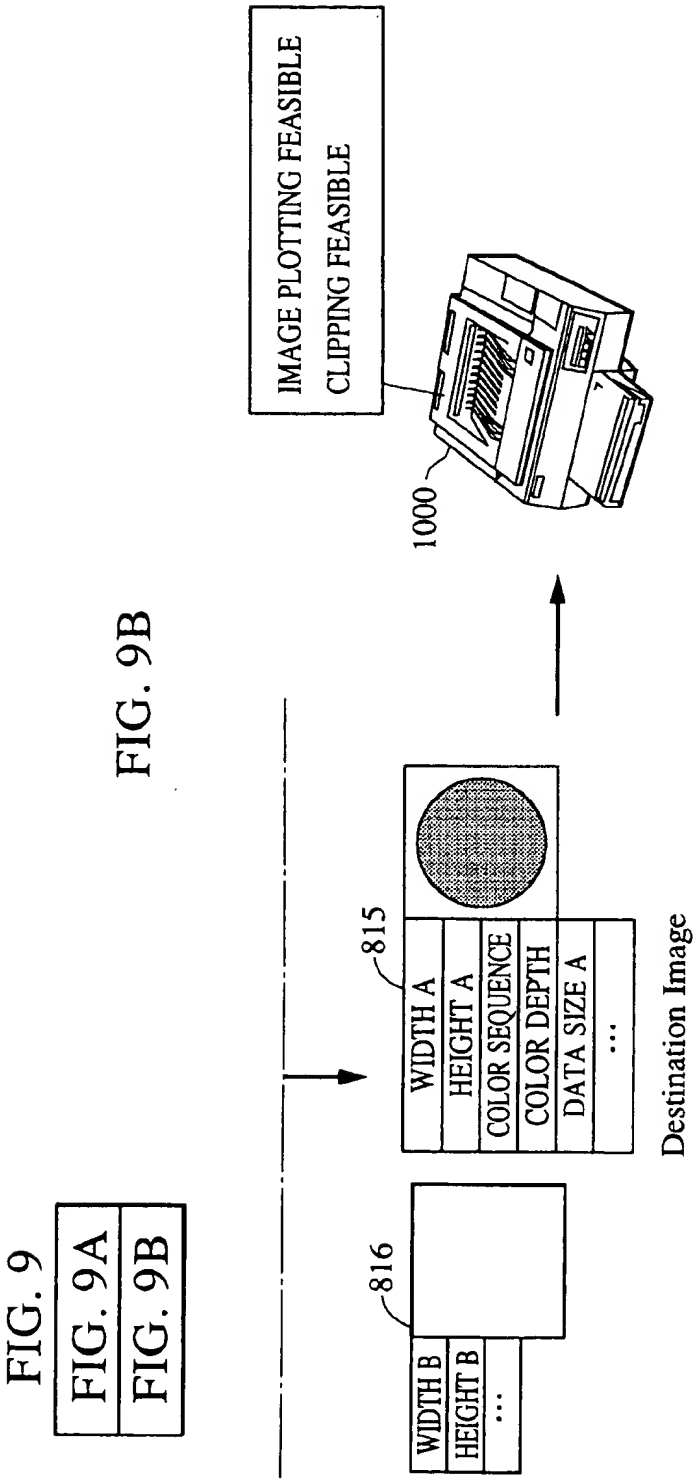


FIG. 9B

FIG. 9

FIG. 9A
FIG. 9B

FIG. 10

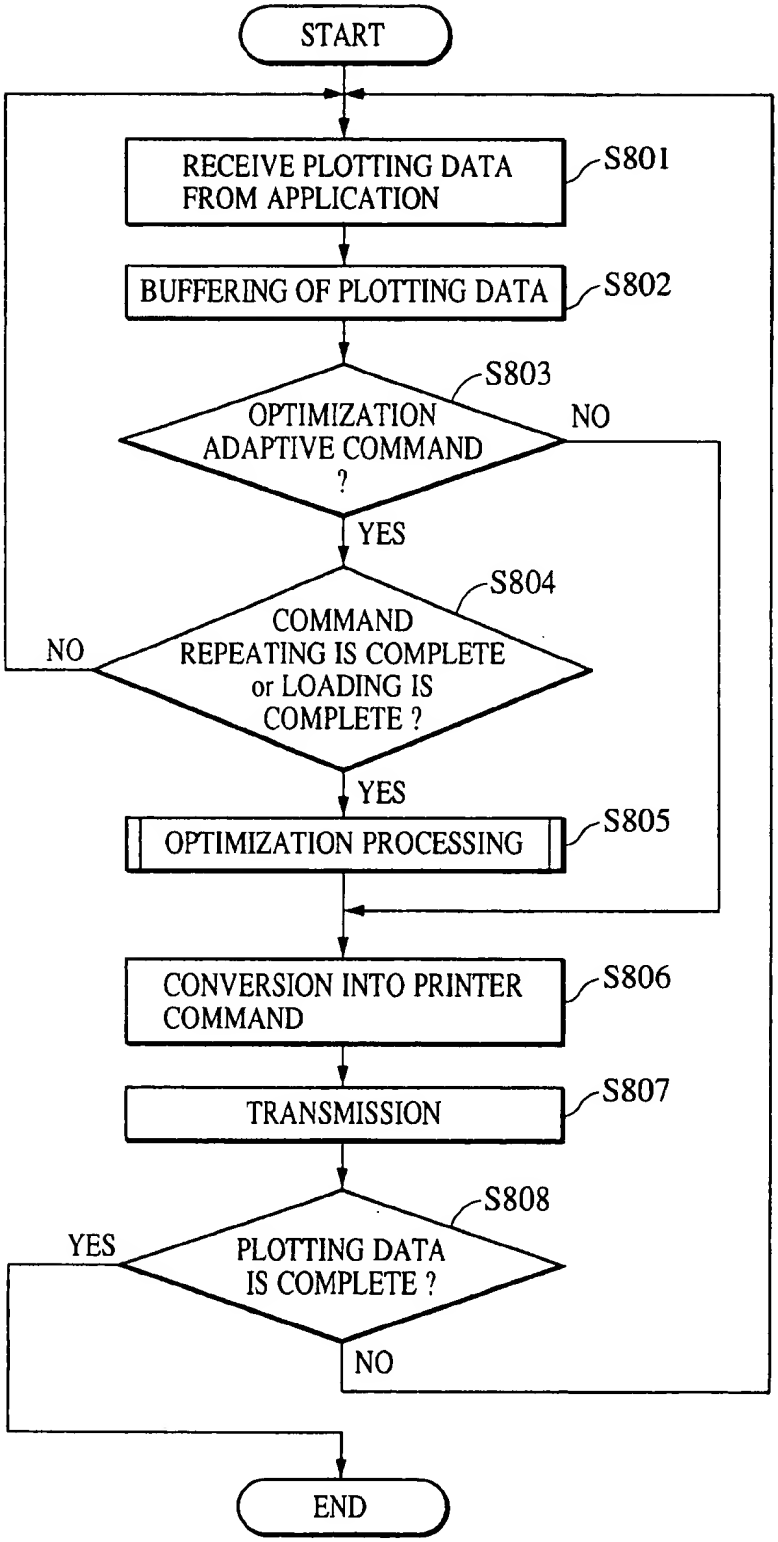
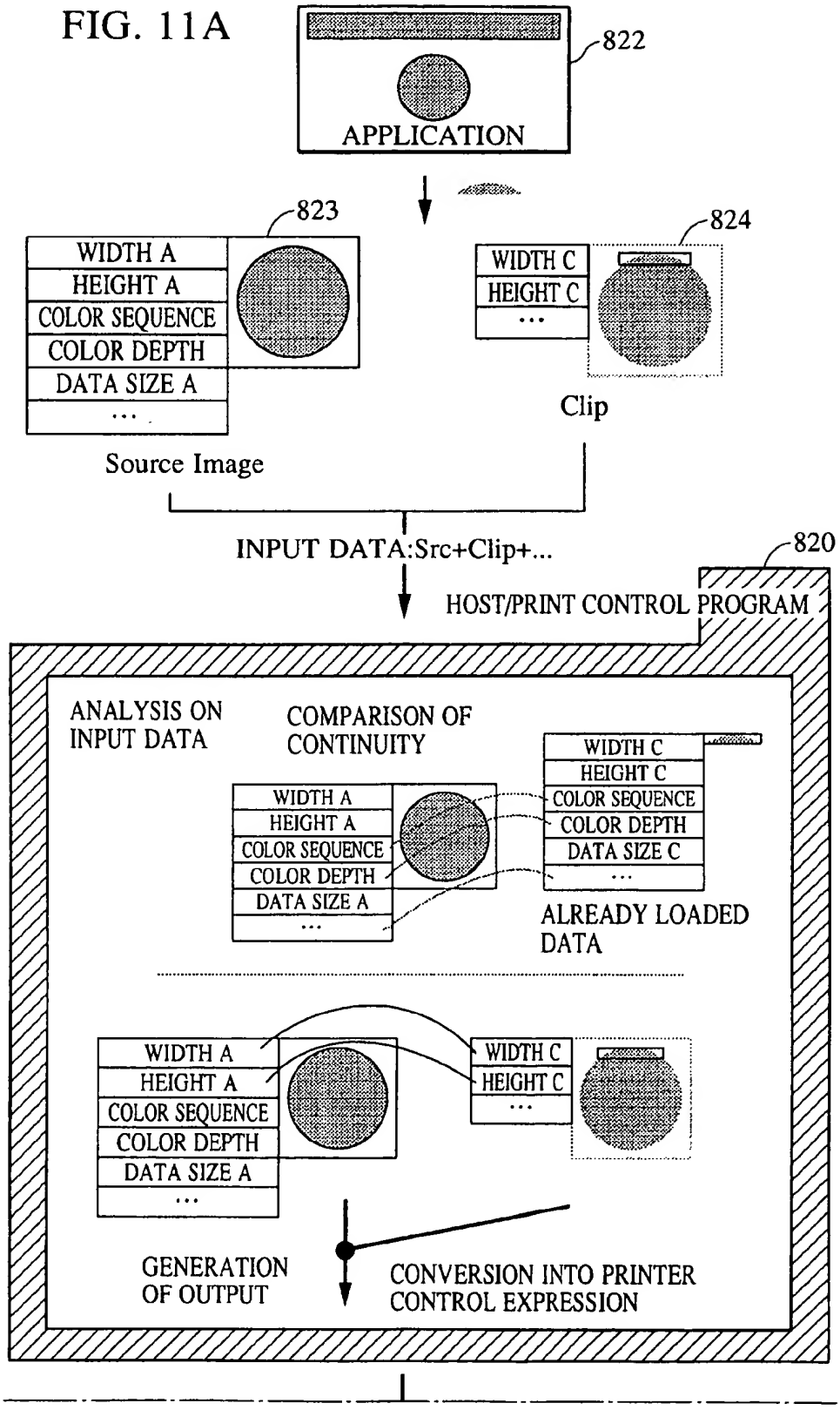

START
RECEIVE PLOTTING DATA FROM APPLICATION
S801
BUFFERING OF PLOTTING DATA
S802
S803
OPTIMIZATION ADAPTIVE COMMAND ?
NO
YES
S804
COMMAND REPEATING IS COMPLETE or LOADING IS COMPLETE ?
NO
YES
OPTIMIZATION PROCESSING
S805
CONVERSION INTO PRINTER COMMAND
S806
TRANSMISSION
S807
S808
PLOTTING DATA IS COMPLETE ?
YES
NO
END

FIG. 11A


822
APPLICATION
823
WIDTH A
HEIGHT A
COLOR SEQUENCE
COLOR DEPTH
DATA SIZE A
...
Source Image
824
WIDTH C
HEIGHT C
...
Clip
INPUT DATA:Src+Clip+...
820
HOST/PRINT CONTROL PROGRAM
ANALYSIS ON INPUT DATA
COMPARISON OF CONTINUITY
WIDTH A
HEIGHT A
COLOR SEQUENCE
COLOR DEPTH
DATA SIZE A
...
WIDTH C
HEIGHT C
COLOR SEQUENCE
COLOR DEPTH
DATA SIZE C
...
ALREADY LOADED DATA
WIDTH A
HEIGHT A
COLOR SEQUENCE
COLOR DEPTH
DATA SIZE A
...
WIDTH C
HEIGHT C
...
GENERATION OF OUTPUT
CONVERSION INTO PRINTER CONTROL EXPRESSION

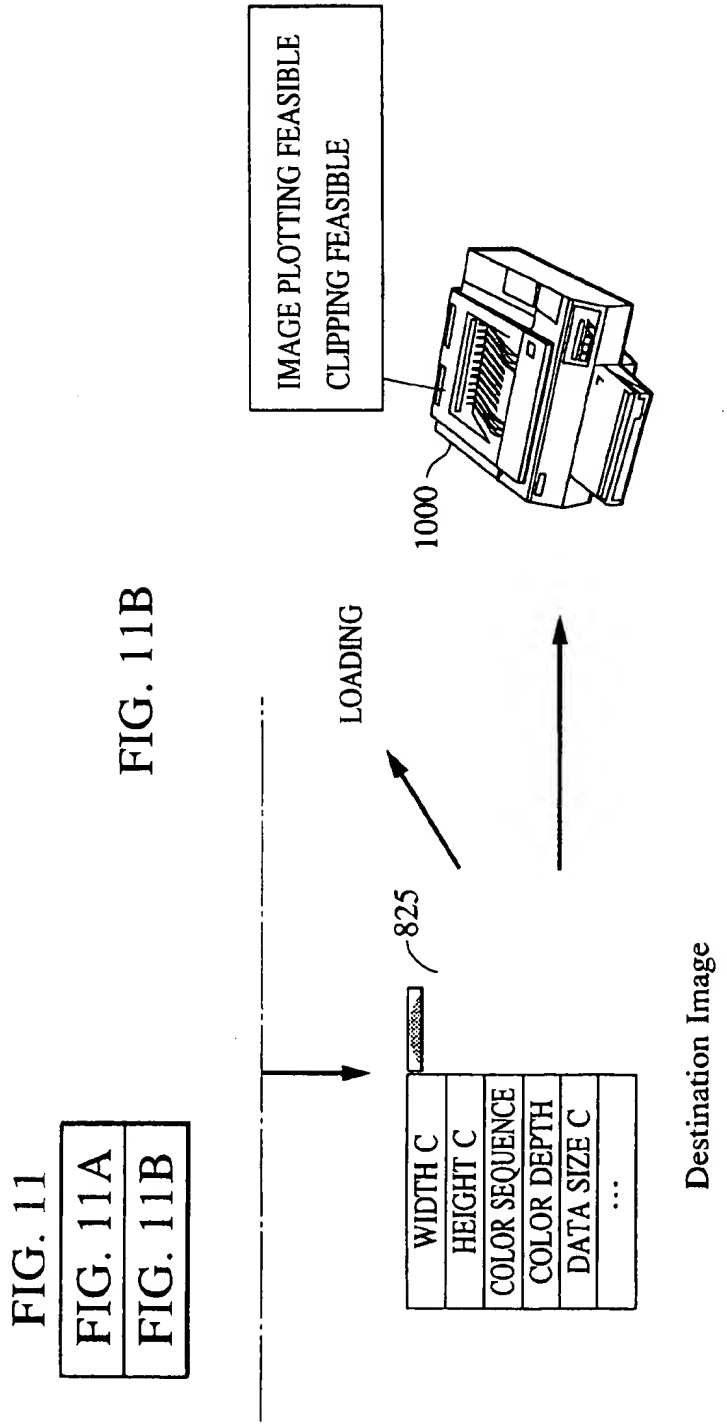


FIG. 11B

FIG. 11

FIG. 11A
FIG. 11B

FIG. 12A

FIG. 12

FIG. 12A

FIG. 12B

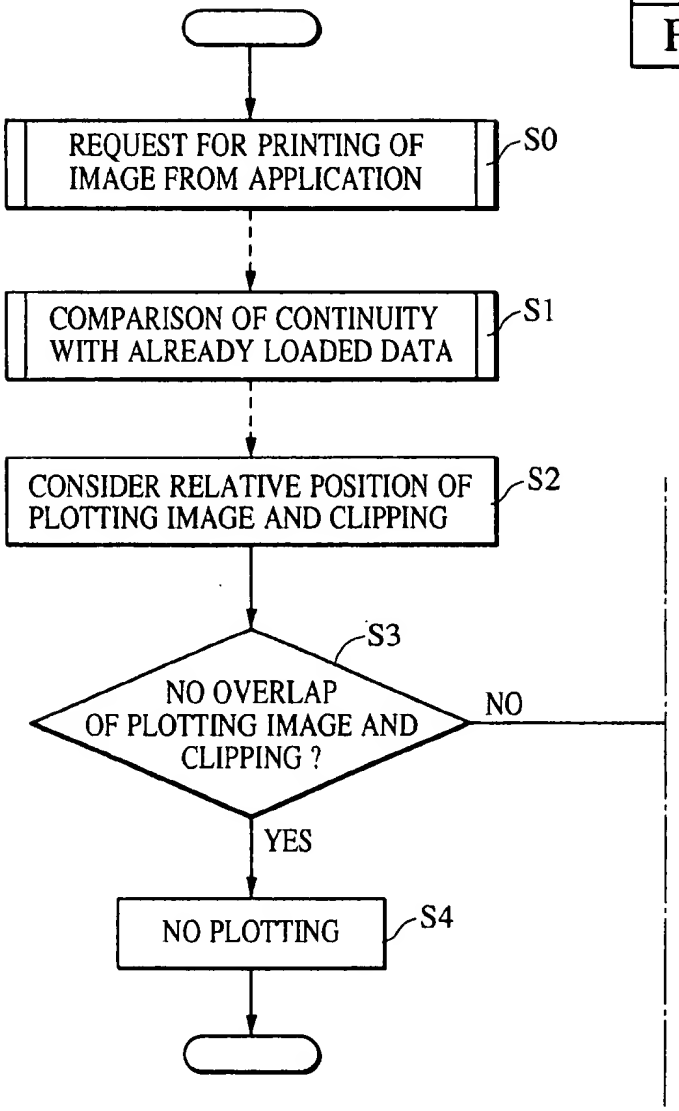
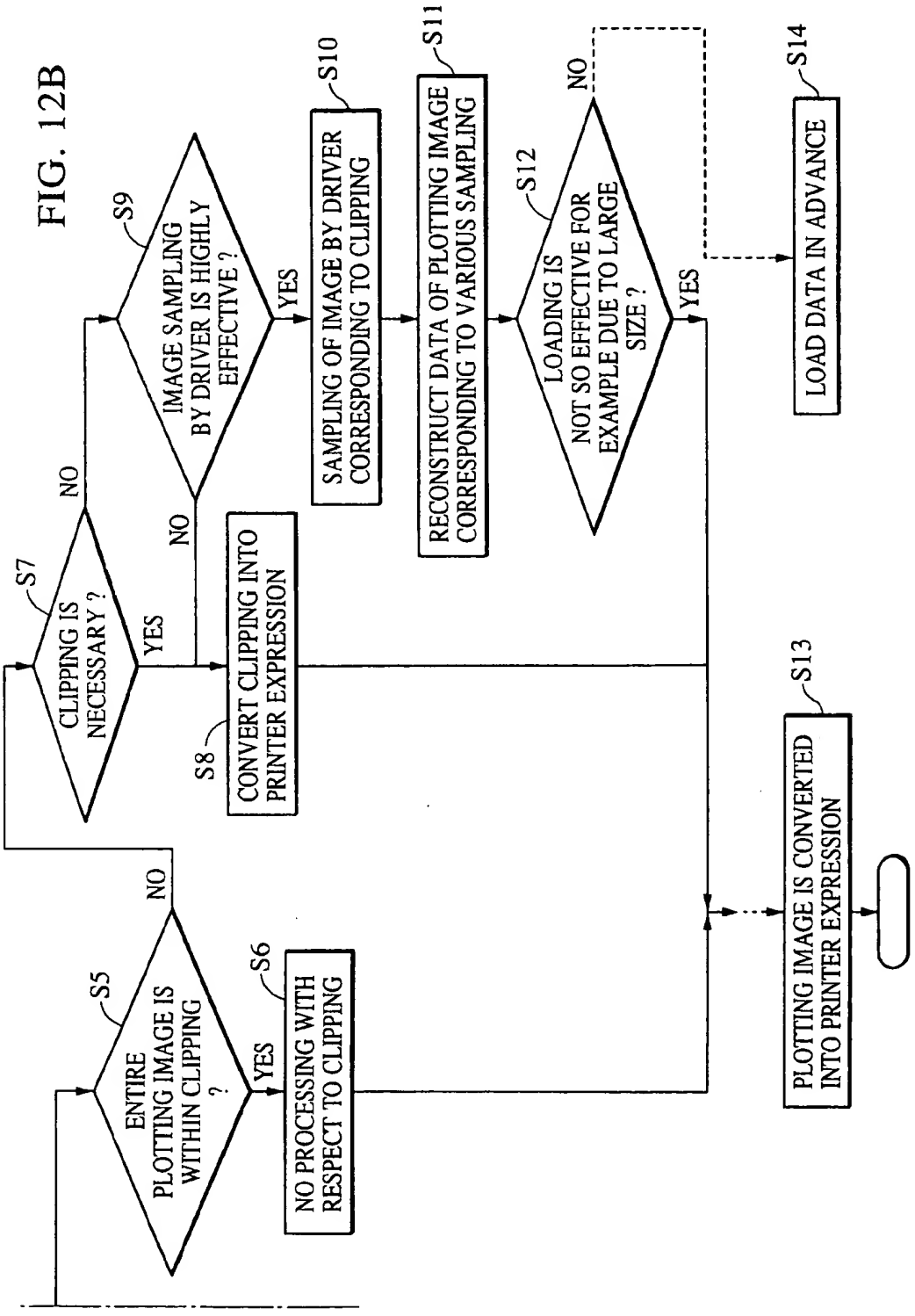


FIG. 12B


S5
ENTIRE PLOTTING IMAGE IS WITHIN CLIPPING ?
NO
YES
S6
NO PROCESSING WITH RESPECT TO CLIPPING
S7
CLIPPING IS NECESSARY ?
NO
YES
S8
CONVERT CLIPPING INTO PRINTER EXPRESSION
S9
IMAGE SAMPLING BY DRIVER IS HIGHLY EFFECTIVE ?
NO
YES
S10
SAMPLING OF IMAGE BY DRIVER CORRESPONDING TO CLIPPING
S11
RECONSTRUCT DATA OF PLOTTING IMAGE CORRESPONDING TO VARIOUS SAMPLING
S12
LOADING IS NOT SO EFFECTIVE FOR EXAMPLE DUE TO LARGE SIZE ?
NO
YES
S13
PLOTTING IMAGE IS CONVERTED INTO PRINTER EXPRESSION
S14
LOAD DATA IN ADVANCE

PRINTER CONTROLLING APPARATUS AND METHOD AND RECORDING MEDIUM FOR RECORDING PROGRAM CODE FOR EXECUTING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to printer controlling apparatus and methods for processing print data generated for print output for example by an application program of a host computer and also relates to a recording medium for recording a program code for executing the same.

1. Description of the Related Art

Usually, when a document prepared by using an application program is to be printed, a printer driver is driven in accordance with a printing procedure of the application. The printer driver converts the print data into a print command by the driven procedure and transmits it to a printer apparatus. Upon receiving the print command, the printer apparatus sequentially analyzes and executes the received command.

However, the printing procedure of an application program is a characteristic of the application. Some of the newly developed applications with high-level functions are designed to repeat the same plotting process again and again or to divide a figure consisting of a large block into small parts or to combine an enormous number of figures to print an area which will, after all, be plotted as a small figure.

Such print data not only increases the amount of data to be transmitted but also results in a problem that, considering only the printed result, an unnaturally long time period is required due to the fact that the apparatus for processing such data is also greatly loaded.

Furthermore, since only a minimized amount of memory is commonly mounted on a printer apparatus because of a limitation of costs, the plotting operation may become impossible due to a shortage of memory that is necessary to process the plotting data when a great amount of plotting data as described is to be processed.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a printer controlling apparatus and method and a recording medium for recording a program code for executing the same with which the above described problems are solved so that, even when plotting data with a high level of redundancy is generated by an application program to be utilized, it is possible to prevent a requirement for long time period until its output or an occurrence of impossibility of plotting.

To achieve the above object, an image processing apparatus is provided in accordance with the present invention, having a printer control apparatus for processing print data generated for print output by an application program of a host computer, comprising: buffer means for buffering a plurality of plotting data generated by said application; and optimization means for arranging the plurality of plotting data buffered in said buffer means into a single data.

Further, an image processing method according to the present invention includes the steps of: buffering a plurality of plotting data generated by an application program of a host computer; determining whether the plurality of buffered plotting data can be described by one plotting data; and, when determined as capable of being described by one plotting data, converting the plurality of buffered plotting data into one plotting data.

Furthermore, a recording medium according to the present invention stores a program code readable by a computer, said program code comprising:

means for buffering a plurality of plotting data generated for print output by an application program; and

optimization means for converting the plurality of buffered plotting data into one plotting data.

Other objects and advantages of the present invention will be more apparent from the accompanying drawings, claims and detailed description below.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side sectional view showing the construction of a laser beam printer of Embodiment 1.

FIG. **2** is a block diagram showing the fundamental construction of a printer apparatus according to Embodiment 1.

FIG. **3** is a flowchart of print control procedure of Embodiment 1.

FIG. **4** is a flowchart of the procedure of plotting shown in Fig.**3**.

FIG. **5** is a block diagram showing the fundamental construction of a printer apparatus according to Embodiment 2.

FIG. **6**, which consists of FIGS. **6**(*a*)–**6**(*d*), illustrates an example of plotting data optimization according to an embodiment.

FIG. **7**, which consist of FIGS. **7**(*a*)–**7**(*d*), illustrates an example of optimization of plotting data.

FIG. **8** is a block diagram showing the construction of a printer control system according to Embodiment 3.

FIG. **9**, which consists of FIGS. **9**A and **9**B, schematically illustrates an image print processing.

FIG. **10** is a flowchart showing a print control procedure according to Embodiment 3.

FIG. **11**, which consists of FIGS. **11**A and **11**B, schematically illustrates an image print processing characteristic of the present invention.

FIG. **12**, which consists of FIGS. **12**A and **12**B, is a flowchart of an example of optimization processing.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Some preferred embodiments of the present invention will be described below in detail with reference to the accompanying drawings.

Before describing the construction of the present invention, the construction of a laser beam printer (hereinafter referred to as "LBP") to which the present invention may be suitably applied will be described below with reference to FIG. **1**. It should be noted that, naturally, the printer to which the present invention is applied is not limited to a laser beam printer and printers using other printing methods may be used.

FIG. **1** is a sectional view showing the internal structure of a laser beam printer suitable for the present embodiment. Referring to FIG. **1**, what is denoted by numeral **1000** is the body of a LBP which receives and stores character information (character code) and form information or macro commands supplied from a host computer externally connected thereto and produces corresponding character patterns, form patterns or the like in accordance with these informations to form an image on a recording sheet. An

operation panel **1012** is provided with switches for operation, LED indicators, etc., disposed thereon and a printer control unit **1001** controls the LBP **1000** as a whole and analyzes character information or the like supplied from the host computer. The control unit **1001** mainly converts a character information into a video signal of corresponding character pattern and outputs it to a laser driver **1002**. The laser driver **1002** is a circuit for driving a semiconductor laser **1003** and effects ON/OFF switching of a laser beam **1004** emitted from the semiconductor laser **1003** in accordance with the input video signal. The laser **1004** is deflected in a left and right direction by a rotary polygon mirror **1005** and scans over an electrostatic drum **1006**. An electrostatic latent image of the character pattern is thereby formed on the electrostatic drum **1006**. This latent image is transferred onto the recording paper after its being developed by a developing unit **1007** provided around the electrostatic drum **1006**. A cut sheet is used as the recording paper. The cut sheet recording paper is set in a paper cassette **1008** mounted on the LBP and is taken into the apparatus by a feeding roller **1009** and carrier rollers **1010** and **1011** so as to be sent to the electrostatic drum **1006**.

FIG. **2** is a block diagram showing the construction of software of LBP **1000** (especially of the control unit **1001**) according to the present embodiment. Referring to FIG. **2**, a host computer **2000** is connected to the printer apparatus **1000** and outputs to the printer apparatus **1000** a print information consisting of print data and control code. The printer apparatus **1000** is generally constituted by a formatter control section **1100** (provided within the above described control unit **1001**), interface **1200**, output control section **1300**, and printer engine section **1400**. The formatter control section **1100** comprises a receiving buffer **1101**, a command discriminating section **1102**, a command analyzing section **1103**, a command executing section **1104**, a page memory **1105**, and a data format determining section **1106**. Further, the command analyzing section **1103** includes an application list **1103***a* and optimization routine **1103***b*. The receiving buffer **1101** is a storage means for temporarily retaining print information received from the host computer **2000**. The command discriminating section **1102** is to perform discrimination of each print control command, and print data is analyzed at the command analyzing section **1103** in accordance with each command. The command analyzing section **1103** is to perform analysis on each print control command. When an application name which is an application discriminating data is received at the command discriminating section **1102**, the application name is sequentially compared with the application list **1103***a*. The application list **1103***a* is a table describing application names and contrast between the subject command to be optimized and an optimization routine. When the received application name exists within the application list **1103***a*, an analysis is made by switching the routine for analyzing commands which are the subject of optimization to a corresponding command analyzing routine in the optimization routine **1103***b*. The command analyzing section **1103** analyzes print information and thereby converts each print control command into the form of an intermediate code having a format which is more readily processed at the command executing section **1104**. The command executing section **1104** executes processing corresponding to each command based on the intermediate code and, for those commands related to plotting and printing, sequentially expands a corresponding pattern into the page memory **1105**. On the other hand, when it is determined as a simple bit map at the data format determining section **1106**, the image data is expanded into the page memory **1105** as it is. It should be noted that the formatter control section **1100** is generally constructed by a computer system using CPU, ROM, RAM, etc. The output control section **1300** converts the content of the page memory **1105** into a video signal and transmits it to the printer engine section **1400**. The printer engine section **1400** is the section of printing mechanism for forming the received video signal into a permanent visible image on the recording paper.

The total print control processing procedure in the present embodiment with the printer apparatus constructed as the above will be described below with reference to flowcharts shown in FIGS. **3** and **4**. The respective processing steps are indicated by **S301** to **S308** in FIG. **3** and **S401** to **S408** in FIG. **4**.

FIG. **3** shows the main processing from start to end of operation of the printer apparatus **1000**. First, at step **S301**, print data sent from the host computer **2000** is received and is stocked up in the receiving buffer **1101**. Next, the print data stocked in the receiving buffer is read at step **S302** and, at step **S303**, it is determined at the command discriminating section **1102** whether or not the print control command is an application name informing command. If it is an application name informing command, the system proceeds to step **S304** where the received application name is sequentially compared with the application list **1103***a*. It is then determined at step **S305** whether or not a corresponding application name exists in the application list. If exists, the command analyzing routine for comparison is switched to an optimization routine at step **S306**, and the system proceeds to plotting process of step **S307**. On the other hand, when the command received at step **S303** is not an application name informing command or when the application name received at step **S305** does not exist in the application list, the system directly proceeds to step **S307** where plotting is performed, and it is then determined at step **S308** whether a print terminating command (job terminating command) has been received or not or whether print data has ended or not. If it is an end of printing, the printing operation is terminated. If not an end of printing, processing of step **S301** and after is repeated.

FIG. **4** explains plotting process (**S307**) as used in FIG. **3**. First, at step **S401**, it is checked at the command analyzing section **1103** whether data is a paper discharge instruction or not and, if a paper discharge command, the system proceeds to step **S406** to perform a corresponding processing. Further, when it is not a paper discharge command at step **S401**, it is then determined whether or not the analyzed command is a command for expansion to the page memory such as character printing or graphic plotting (step **S402**) and, if not, the system proceeds to step **S405** where processing corresponding to such command is executed. If the system proceeds to step **S403** from step **S402**, an intermediate code in a form more readily processed by executing commands is generated. Upon receiving the intermediate code, an expansion processing to the page memory **1105** is performed at the command executing section **1104** (step **S404**), and, after completion of expansion processing with respect to one print or plotting command, the system returns to step **S302** of FIG. **3** where data analyzing process is repeated. If it is determined as a paper discharge instruction at step **S401**, the content of the page memory **1105** is output as an image transfer by converting it into a video signal for the printer engine section **1400** at the output control section **1300** (step **S406**). At the printer engine section **1400**, printing is performed by forming the received video signal into a permanent visible image on the recording paper (step **S407**). The

print control processing for one page is then terminated when the printed result is discharged at step S408.

While the actions of the printer apparatus as a whole have been described, these are the processing accomplished mainly by the computer system of the formatter control section 1100.

EMBODIMENT 2

FIG. 5 shows the main processing from start to end of operation of the printer apparatus 1000 of this embodiment. The respective processing steps are indicated by S501 to S509 in FIG. 5. Note that the plotting process in FIG. 5 is similar to that of Embodiment 1 and will not be described.

First, at step S501, print data sent from the host computer 2000 is received and stocked in the receiving buffer 1101. Next, a command chain stocked in the receiving buffer is read out at step S502 and it is determined at step S503 whether a determination on command optimization has been made or not. If a determination on optimization has not yet been made, a characteristic is extracted from the transmitting method of the command chain at step S504. In particular, it is for example a correlation between the respective commands of coordinate parameters, area size, etc. The characteristics extracted at step S505 are then sequentially compared with a list of table corresponding to the application list of Embodiment 1, and it is determined at step S506 whether a matching characteristic exists in the list. If there is a matching characteristic at step S506, the system proceeds to step S507. At step S507, the command processing routine corresponding to the list is switched to the optimization routine and the system then proceeds to plotting process of step S508. On the other hand, when a determination on optimization has already been made at step S503 or when a list with a matching characteristic is not found at step S506, the system directly proceeds to step S508 where plotting is performed and it is then determined at step S509 whether a print terminating instruction has been received or not or whether print data has ended or not. If it is an end of print, the printing operation is terminated. If not an end of print, processing of step S501 and after is repeated.

FIGS. 6 and 7 show an example of optimization of plotting process by the optimization routine (S306, S506). A further description of the optimization routine will be given later with reference to FIG. 12.

For example, as shown in FIG. 6, when a command chain such as one plotting polygons (rectangle) by consecutively shifting coordinates by a small amount at a time (a) has been generated by and transmitted from an application program, the respective polygons are individually plotted (b) by a conventional printer apparatus since the commands are sequentially analyzed and executed. Consequently, an image as indicated by (d) is obtained. In the present embodiment, a characteristic of transmitting by the application is previously recognized so that they are replaced by a command for plotting a single rectangle (c) through the above described optimization routine without affecting the image to be obtained at the end (d).

Further, as shown in FIG. 7, when a command chain such as one plotting the same image data at the same position again and again with changing the area to be clipped has been transmitted (a), a conventional printer apparatus effects a plotting faithfully in accordance with each command chain (b). In this embodiment, they are converted into commands (c) for plotting an image of the area to be clipped through an optimization routine without affecting the image (d) to be obtained at the end. In FIG. 7, of the area for which image data is sent by plotting instruction (the portion of rectangle formed by broken lines in the figure), actual plotting is performed only in the area specified by clipping instruction (the portion of rectangle formed by solid lines in the figure).

While, in the above described Embodiments 1 and 2, the received commands are converted through an optimization routine and then converted into an intermediate code, it is also possible to generate an optimized intermediate code from the received command or to optimize an intermediate code after converting the received command into an intermediate code.

EMBODIMENT 3

FIG. 8 is a block diagram for explaining the construction of a printer control system showing Embodiment 3 of the present invention. Here, a description will be given below using the laser beam printer (FIG. 1) as an example. Naturally, as far as the function of the present invention can be executed, the present invention may be applied to any of a single equipment, a system consisting of a plurality of equipments or a system in which data is processed through a network such as LAN.

Referring to FIG. 8, what is denoted by numeral 3000 is a host computer, which includes a CPU 1 for executing a document processing where pattern, image, character, table (including listing or the like), etc., are mixed based on a document processing program stored in a program ROM of ROM 3, the CPU 1 generally controlling the devices connected to a system bus 4. The program ROM of the ROM 3 stores a control program or the like of CPU 1, font ROM of the ROM 3 stores font data or the like to be used in the above document processing, and data ROM of the ROM 3 stores various data to be used in performing the above document processing, etc. RAM 2 functions as a main memory of CPU 1, work area, etc. A keyboard controller (KBC) 5 controls key input from a keyboard 9 or a pointing device (not shown). A CRT controller (CRTC) 6 controls display on a CRT display (CRT) 10. Memory controller (MC) 7 controls access to an external memory 11 such as a hard disk (HD) or floppy disk (FD) for storing a boot program, various applications, font data, user file, edit file, etc. A printer controller (PRTC) 8 is connected to a printer 1000 through a predetermined bidirectional interface 21 to execute communication control processing with the printer 1000. It should be noted that the CPU 1 executes expansion (rasterize) processing of outline font onto a display information RAM provided for example on RAM 2 so as to make WYSIWYG on the CRT 10 possible. Further, the CPU 1 opens various windows entered based on commands directed by a mouse cursor or the like (not shown) on the CRT 10 to execute various data processing. In the printer 1000, a printer CPU 12 generally controls access with various devices connected to a system bus 15 based for example on a control program stored in the program ROM of ROM 13 or a control program stored in an external memory 14 and outputs an image signal as an output information to a printing section (printer engine) 17 which is connected thereto through a printing section interface 16.

Further, a control program or the like of CPU 12 as shown in a flowchart of Embodiment 1 or 2 can be stored to the program ROM of ROM 13.

Font data or the like to be used in generating the above output information is stored to the font ROM of ROM 13, and, in the case of a printer without the external memory 14 such as a hard disk, information or the like for use on the host computer is stored to the data ROM of ROM 13. CPU 12 is capable of communication processing with the host computer through an input section 18 and is constructed so that information or the like within the printer can be given to the host computer 300. What is denoted by numeral 19 is a RAM which functions as a main memory, work area, etc. of CPU 12 and is constructed so that memory capacity thereof can be extended by an optional RAM connected to an extension port (not shown). It should be noted that the

RAM **19** is used for example as an output information expansion area, environment data storage area, NVRAM, etc. Access to the external memory **14** such as the above described hard disk (HD) or IC card is controlled by a memory controller (MC) **20**. The external memory **14** is connected as an option and stores font data, emulation program, form data, etc. What is denoted by numeral **18** is the above described operation panel and has switches for operation and LED display indicator, etc., disposed thereon. The number of the above described external memory is not limited to one. At least one unit is provided and it may also be constructed such that a plurality of optional font card in addition to internal font or of external memory for storing program to interpret a printer control language of a different language system can be connected thereto. Furthermore, an NVRAM (not shown) may also be provided so as to store a printer mode setting information from the operation panel **1012**.

Next, in a printing system constructed as the above, FIG. **9** summarizes an ordinary image print processing. The printer **1000** is capable of both plotting and clipping an image. An example is shown here of the case where printing of an image from an application program of a host computer is effected with such printer **1000**. First, an output object represented for example by an image plotting command **813** or clipping command **814** from the application is delivered. A host/print control program (printer driver) **810** converts the object into a control representation of the printer. The printer driver **810** is provided by FD or the like or stored in HD in advance. Since, as described above, the printer **811** is capable of both image plotting and clipping, the image plotting command **813** or clipping command **814** requested for printing by the application **812** is transmitted to the printer in a manner converted into an image plotting command **815** or clip command **816** of a control representation of the printer. Printing is then effected at the printer **1000**.

In this embodiment, the optimization of plotting process in Embodiment 1 and Embodiment 2 is performed on the host computer side in accordance with the printer driver **810**. The print control processing procedure as a whole in the present embodiment will now be described with reference to the flowchart shown in FIG. **10**. The respective processing steps are indicated by S**801** to S**808** in FIG. **10**.

FIG. **10** shows main processing from start to end of printing of the host computer **3000**. First, at step S**801**, plotting data is received from an application program, and the plotting data is first buffered at step S**802**. Next, it is determined at step S**803** whether or not the data is of the kind to which an optimization should be applied. If determined as the kind of data to be optimized, it is further determined at step S**804** whether repetition of the same command chain has been terminated or not and whether buffering has been repeated up to a threshold or not. If negative results are obtained for the both, processing of step S**801** and after is repeated. If repetition of the same command chain has been terminated or if buffering has been repeated up to a threshold at step S**804**, optimization processing is performed at step S**805**. The optimization processing will be described later. Thereafter, the optimized data is converted into a printer command at step S**806**. On the other hand, if it is determined at step S**803** not as data to which an optimization should be applied, the system directly proceeds to step S**806** where data is converted into printer command and it is then transmitted to a printer apparatus at step S**807**. Thereafter, the system proceeds to step S**808** where it is determined whether plotting data from application has ended. If an end of plotting data, plotting is terminated. If not an end of plotting data, the system returns to step S**801** and processing is repeated accordingly.

Next, a generalized example of optimization in an image print processing is shown in FIG. **11** and a effected in such a manner as to replace those of large width by those of clip. Further, conversion into a printer control expression is not immediately performed at this point; an extraction of the image is performed so as to retain it as it is in the form of input data. A comparison of continuity is made at a point in time when this output routine is next called (pallet, color depth, plotting position, etc.). If there is no continuity, it is output as converted into a printer control expression. If there is a continuity, however, loading is repeated. As a result, a plotting image **825** in the form of printer control expression is obtained. The clipping object is not directly converted into a printer control expression.

While, in Embodiment 1, an application name is transmitted to the printer apparatus, a different signal may be used as far as it is a type of trigger capable of switching processing.

Further, in Embodiment 1, a table is internally provided to previously retain as an information on the characteristics of data transmission of a plurality of application programs. If, however, the number of targeted applications is small, it is also possible to determine whether an optimization should be effected or not without having a table.

Similarly, while, in Embodiment 2, the flowchart thereof is shown in FIG. **12**.

Similarly to FIG. **9**, the printer **1000** is capable of both plotting and clipping of an image. An example is shown here of the case where printing of an image is effected with such printer **1000** from an application **822** of a host computer. First, upon a request for printing an image from an application, an output object represented such as by an image plotting command **823** or clip command **824** is delivered. The host/print control program (printer driver) **810** converts the object into a control expression of the printer. In the case shown in FIG. **11**, the clipping area of the clip command **824** corresponds to only a small portion of the image plotting area of the image plotting command **823**. The host/print control program **810** makes a comparison of attributes between the plotting image and the clip object and is capable of determining that the clip is significantly smaller as shown in the figure. In this case, if a method is employed of effecting clipping at the computer and then plotting a plotting image, most of the plotting image data do not affect the plotting result but are to be transmitted to the printer **1000**. Then, at the time of conversion into printer control expression, only the area corresponding to the clip is extracted from the image and conversion into control expression of the printer is characteristics of command chain are provided in a table, it is also possible to make a decision on an optimization without using a table.

In Embodiment 3, an optimization is treated as a single operation when command chains are being repeated. In the case where the application name is previously known, however, it is also possible to buffer a plurality of command chains according to the characteristic of the application to perform a plurality of optimization processing.

As has been described above, according to the present invention, a redundant print data is optimized according to the characteristics of the print data so that an efficient plotting process is achieved and a high speed printing becomes possible. Further, since memory required by the printer apparatus can be saved, an impossibility of plotting due to memory shortage can be prevented and it is possible to lower the product cost.

What is claimed is:

1. An image processing apparatus for processing output data generated for image output by an application on a host computer, said image processing apparatus comprising:

buffer means for buffering a plurality of plotting data instructions generated by the application program; and

optimization means for arranging the plurality of plotting data instructions buffered by said buffer means into one plotting data instruction.

2. A printer apparatus comprising an image processing apparatus for processing output data generated for image output by an application on a host computer, said image processing apparatus comprising:

buffer means for buffering a plurality of plotting data instructions generated by the application program; and

optimization means for arranging the plurality of plotting data instructions buffered by said buffer means into one plotting data instruction.

3. A host computer comprising an image processing apparatus for processing output data generated by an application on said host computer for image output to a printer apparatus, said image processing apparatus comprising:

buffer means for buffering a plurality of plotting data instructions generated by the application program; and

optimization means for arranging the plurality of plotting data instructions buffered by said buffer means into one plotting data instruction.

4. An image processing apparatus according to claim 1, further comprising means for determining whether said optimization means is to be used or not by a type of the application program.

5. An image processing apparatus according to claim 1, further comprising:

means for extracting characteristics of the plurality of plotting data instructions; and

means for determining whether said optimization means is to be used or not based on the extracted characteristics.

6. An image processing apparatus according to claim 4, wherein said means for determining uses application discriminating data and a table of plotting commands and optimization routines.

7. An image processing apparatus according to claim 1, wherein said optimization means uses a table of plotting commands and optimization routines.

8. An image processing apparatus according to claim 1, wherein said optimization means converts a first plotting data instruction and a second plotting data instruction into a third plotting data instruction, the first plotting data instruction containing a plotting instruction and position data of image data to be plotted and the second plotting data instruction containing a clipping instruction and area data to be clipped.

9. An image processing apparatus according to claim 8, wherein, when a clipping area to be clipped defined by the area data is within a plotting area of the image data, said optimization means effects a conversion such that the third plotting data instruction contains image data within the clipping area, a plotting instruction of the image data and position data indicating the clipping area.

10. An image processing apparatus according to claim 1, wherein said optimization means converts a plurality of plotting data instructions containing respective painting instructions and area data to be painted into a plotting data instruction containing area data synthesizing the painting instructions and the area data.

11. An image processing method comprising the steps of:

buffering a plurality of plotting data instructions generated for image output by an application program of a host computer;

determining whether or not the plurality of buffered plotting data instructions can be described by a single converted plotting data instruction;

and when it is determined that the plurality of buffered plotting data instructions can be described by a single converted plotting data instruction, converting the plurality of buffered plotting data instructions into the converted plotting data instruction.

12. An image processing method according to claim 11, further comprising the step of printing based on the converted plotting data instruction.

13. An image processing method according to claim 11, further comprising the step of outputting the converted plotting data instruction to a printer.

14. An image processing method according to claim 11, said determining step determines whether said converting step is to be effected or not by a type of the application program.

15. An image processing method according to claim 11, further comprising the steps of:

extracting characteristics of the plurality of plotting data instructions; and

determining whether said converting step is to be effected or not based on the extracted characteristics.

16. An image processing method according to claim 14, wherein a determination in said step of determining is made using application discriminating data and a table of plotting commands and optimization routines.

17. An image processing method according to claim 11, wherein said converting step uses a table of plotting commands and optimization routines.

18. An image processing method according to claim 11, wherein in said step of converting, a first plotting data instruction and a second plotting data instruction are converted into a third plotting data instruction, the first plotting data instruction containing a plotting instruction and position data of image data to be plotted and the second plotting data instruction containing a clipping instruction and area data to be clipped.

19. An image processing method according to claim 18, wherein, when a clipping area to be clipped defined by the area data is within a plotting area of the image data, said step of converting effects a conversion such that the third plotting data instruction contains image data within the clipping area, a plotting instruction of the image data and position data indicating the clipping area.

20. An image processing method according to claim 11, wherein said step of converting converts a plurality of plotting data instructions containing respective painting instructions and area data to be painted into a plotting data instruction containing area data synthesizing the painting instructions and the area data.

21. A computer readable medium which, when inserted into a programmable apparatus, causes said apparatus to execute an image processing method comprising the steps of:

buffering a plurality of plotting data instructions generated for image output by an application program of a host computer;

determining whether or not the plurality of buffered plotting data instructions can be described by a single converted plotting data instruction; and

when it is determined that the plurality of buffered plotting data instructions can be described by a single converted plotting data instruction, converting the plurality of buffered plotting data instructions into the converted plotting data instruction.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,832,192

DATED : November 3, 1998

INVENTOR(S) : YASUHIRO HINO

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

COLUMN 7

Line 67, "a effected" should read

--a flowchart thereof is shown in Fig. 12.

¶ Similarly to Fig. 9, the printer 1000 is capable of both plotting and clipping of an image. An example is shown here of the case where printing of an image is effected with such printer 1000 from an application 822 of a host computer. First, upon a request for printing an image from an application, an output object represented such as by an image plotting command 823 or clip command 824 is delivered. The host/print control program (printer driver) 810 converts the object into a control expression of the printer. In the case shown in Fig. 11, the clipping area of the clip command 824 corresponds to only a small portion of the image plotting area of the image plotting command 823. The host/print control program 810 makes a comparison of attributes between the plotting image and the clip object and is capable of determining that the clip is significantly smaller as shown in the figure. In this case, if a method is employed of effecting clipping at the computer and then plotting a plotting image, most of the plotting image data do not affect the plotting result but are to be transmitted to the printer 1000. Then, at the time of conversion into printer control expression, only the area corresponding to the clip is extracted from the

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COLUMN 7

image and conversion into control expression of the printer is effected--.

COLUMN 8

Line 22, "flowchart thereof" should be deleted.
Lines 23-44 should be deleted.
Line 45, "expression of the printer is" should be deleted.

Signed and Sealed this

Fifth Day of October, 1999

Attest:

Attesting Officer

Q. TODD DICKINSON

Acting Commissioner of Patents and Trademarks